Internationalisation of European ICT Activities

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(Editors)

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Dynamics of Information and Communications Technology

Springer

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ISBN 978-3-540-77108-1 e-ISBN 978-3-540-77109-8

DOI 10.1007/978-3-540-77109-8

Library of Congress Control Number: 2008922732

Production: le-tex publishing services oHG, Leipzig
Cover design: WMX Design GmbH, Heidelberg

Printed on acid-free paper

9 8 7 6 5 4 3 2 1

springer.com

Acknowledgement

This book is based on the final report of a study carried out for carried out for the Institute for Prospective Technological Studies (IPTS) of the Joint Research Center (JRC) of the European Commission, on the Internationalisation of European ICT activities. Apart from the efforts made by the authors, the success of this project was made possible through the encouragement and guidelines received from many others. We take this opportunity to express our gratitude to those who helped us in the successful completion of this project.

We would like to thank the staff of IPTS and EC, in particular scientific officers Martin Ulbrich and Geomina Turlea from IPTS, for their support and critical assessment of earlier versions of this final report. The contribution from the team of external experts is greatly appreciated. We would like to thank Tim Kelly from the International Telecommunication Union (ITU), Christian Müller from the Swiss Federal Institute of Technology, Zürich (ETHZ), Hans Lööf from the Royal Institute of Technology (KTH) Stockholm, and Rajneesh Narula from the University of Reading. All accepted our invitation to critically assess earlier versions of this book, their contribution of which was vital for the success of the project. We are grateful for both their support and assistance.

The study was funded by the Institute for Prospective Technological Studies (IPTS, JRC, European Commission) as part of its ongoing work on the Information Society in the European Union (further information is available at: http://www.jrc.es/). The opinions expressed are those of the authors only and do not represent the Commission's official position.

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CHAPTER I. Introduction and Main Policy Lessons

Huub Meijers, Bernard Dachs and Paul J.J. Welfens

The world economy is currently facing a wave of internationalisation or globalisation which can only be compared to that of the second half of the 19th century after the invention of railroads, steamships and the telegraph. The Information and Communication Technologies (ICT) sector is highly affected by these changes and the internationalisation of ICT activities has become a major topic in policy debates and discussions. Next to increasing volumes in trade in ICT goods and services is the increasing tendency to relocate ICT sector production facilities firms' research and development activities to locations outside of their home countries. However, it should be noted that ICT is not only subject to internationalisation and fragmentation, in fact, it is also a major enabler of the process. ICT allows for an easy exchange of information between various locations, and therefore helps to co-ordinate a geographically dispersed production structure.

Internationalisation of ICT is a strategic long term challenge for European Union (EU) economies and the European Community (EC) and its member countries, which involves a number of crucial issues such as growth, employment, technological progress and economic cohesion. In an increasingly digitally networked European and global economy trade, foreign direct investment and international R&D alliances will be strongly shaped by ICTs. In order to get an understanding of ICT internationalisation dynamics, including the impulses for non-ICT sectors in terms of more trade, foreign direct investment, etcetera, one must describe the core developments and key drivers of this process. Given the heterogeneity of the ICT sector, one should use an analytical concept which allows one to distinguish between different subsectors in terms of internationalisation speed, and economic relevance.

Based on theoretical analysis and existing findings of the literature, the presentation of case study material and of new empirical findings with respect to output, trade and investment dynamics, this book allows for the first comprehensive assessment of the internationalisation of European ICT activities. Beyond broad trends, one can highlight within a carefully designed analytical approach, sectoral differentials and cross-country differences and gain an understanding about the relative positioning of EU15/EU10/EU25 within the global economic dynamics. While our analysis shows fields where Europe has considerable strengths, it also indicates that certain problems which must be addressed within a broader growth- and knowledge- society perspective exist. The ICT based potential for endogenous growth, implicitly emphasized in the Lisbon Agenda, must be considered so that various policy suggestions can be developed at both the EU level and the level of EU member states.

ICT is currently perceived as being a force that enables or even drives the current wave of internationalisation. The computer equipment industries as well as the computer service industry are generally being seen as leaders in the international division of (often knowledge intensive) labour. The relocation of ICT hardware production and ICT (enabled) services from the US and Europe to Asia and Eastern Europe has recently gained momentum. Foreign direct investment, imports and exports are booming, especially in specific regions and countries in new EU10 member states such as Estonia, Hungary and the Czech Republic. Next to this, ICT as a general purpose technology, also facilitates this dispersion of production in an effort to settle wherever it is thought to be attractive, taking into account both location factors and objectives.

In some respects, the use of ICT enables economic agents to get information quicker and with lower costs, and also helps them to store and analyse it. It comes as no surprise then, that the geographic distribution of economic activity is determined more strongly than before by (dynamically evolving) comparative advantages between countries and firms. The modularity of production systems and the opportunities to tap into information flows allow for the division of productive activities not only at the level of final products, but also at the level of individual components of products. At the same time ICT use of enterprises, including interconnected systems that enable the logistics necessary to support this division of productive activities even at the level of individual production processes, exists.

The focus of this book is on ICT production (manufacturing, software and services), research and development in ICT, and on the consequences of internationalisation for competitiveness and job creation in these fields. The justification can be found in the perceived threats and opportunities for Europe associated with the 'internationalisation of ICT activities'. Both the re-location of jobs to locations abroad and stagnating welfare are a policymaker's 'bad dream' however, the higher productivity, increased employment and improved welfare that result from ICT production and use in the broadest sense, are considered opportunities.

This book is based on the final report of a study carried out for the European Commission, DG JRC, IPTS, on the Internationalisation of European ICT activities. The objective of the study was to develop a theoretical and practical understanding of the dynamics of internationalisation of the ICT industry in the EU, to compile data about internationalisation of ICT activities, and to use case studies to show how this entrepreneurial behaviour is planned and materialised. Finally, based on the findings, the study developed policy aspects and policy alternatives that promote R&D, competitiveness and job creation.

The book departs from both a theoretical and a practical point of view: instead, it reveals the processes that are underlying the trend of internationalisation. A combination of several methodological approaches is used to explore and analyse the current and emerging trends in internationalisation of ICT. While each of these approaches has its own merits and drawbacks, we strongly believe that a comprehensive combination is the best way to gain insight into what is occurring.

Chapter II highlights the importance of ICT for economic growth and development. Both the production of ICT and its use are decisive for economic growth and productivity. The notion of ICT as being a general purpose technology is highly relevant for decision makers as such technologies open a new era of innovative activities with, often unforeseen new applications, new dynamics, and waves of creative destruction. A second highly relevant observation is the expanding fragmentation of production processes due to standardization, reduced transactions and transportation costs, and increased communication possibilities. Finally, this chapter describes the significance of life cycles of products and services, and the relocation of certain types of activity. Main motives for internationalisation include market expansion, cost reduction, and strategic considerations with respect to knowledge. In many cases, which are confirmed in subsequent chapters by data and by case studies, market expansion is a main motive that firms act on to internationalise their activities. However, cost reduction also seems to play an important role. New knowledge intensive and profitable activities in the earlier stages of the product life cycle, are carried out in home countries whereas in the later stages, the products and services become more standardized, less knowledge intensive, and more easily subjected to relocation. Moreover, from an economic point of view, those production processes which are subject to economies of scale are more likely to be relocated since fixed transaction, communication, and related costs are more easily recovered if scale effects are present. In particular, the combination of these characteristics makes the ICT sector and the use of ICT products and services a highly relevant subject for policy makers.

The literature underlines three main channels of internationalisation: trade, FDI and licensing. These elements are discussed in the Chapters III, IV and V. Chapter III focuses on a practical understanding from the trade perspective. Evidence from trade data shows that EU's trade position with regard to *ICT goods* vis-à-vis the rest of the world shows a trade deficit whereas the EU25 shows a trade surplus in the trade of *ICT services*. Another remarkable outcome from the data analysis is that the differences in import and export prices have been increased in the last decade and the trade volumes are more pronounced. For some products, e.g. automatic data processing machines, the EU25 export price has increased as compared to the imported counterparts, whereas the exports volumes have experienced a relative decrease. On the other hand, for some products we see the opposite where EU's relative export prices decline and relative volumes increase. The analysis of quality differences between imports and exports shows that, on average, EU25 exports are more expensive, and imports are less expensive, products and services. This reinforces the initial hypothesis that more mature products and services (and parts thereof) with lower profit margins are more likely to be relocated than new, innovative, and high value added (parts of) products.

Chapter IV presents the analysis of FDI data and shows similar patterns. For the five European countries for which FDI data where available at a sectoral level, we observe that FDI concentrates on those sectors with a relatively low R&D intensity. Moreover, inward and outward FDI seems to be in balance in most sectors except for the so-called 'traditional scale' sectors where outward FDI is about three times higher compared to inward FDI.

Chapter V analyses ICT related R&D patterns with patent data and shows that R&D activities of European ICT companies are still performed in the home countries for the major part. This however, does not mean that there was no internationalisation in R&D activities. European ICT companies expanded their R&D

activities in other European countries. R&D internationalisation in ICT was therefore mainly an intra-EU phenomenon.

A second important de-centralisation trend that results from analysis in Chapter V, is overseas research in the US. We analyzed the geographical patterns of patenting activity of eight companies, four of which were European. All European companies increased the share of ICT patents invented in the US as well as in other European countries. In other words, the degree of concentration in ICT research has decreased in all cases. Moreover, we could also observe a growing level of knowledge exchange between the US and Europe, i.e. US firms also increasingly benefited from innovative activities conducted in Europe.

Despite large out of country investments of European and US companies, only a small fraction of ICT patents have been created at locations outside the Triad such as China or India, and in the EU10 countries so far. Overall, the patent analysis indicates that leading edge R&D in ICT is still largely concentrated in the US and Europe. We argue that overseas R&D in these countries is mainly 'market driven' and concentrated on developments for local markets, instead of 'technology driven'. Strategic R&D is still concentrated in the home countries of the enterprises.

Aside from the analysis of macro, meso and micro data, the study also includes many case studies on the internationalisation of ICT activities. We conducted a number of light and in-depth case studies, the results of which are outlined in Chapter VI. The main objective for the case studies is to illustrate and complement the theoretical and practical understanding that is developed in the first chapters. Important issues include both the motives and the models of internationalisation. As shown in Chapter II, fragmentation of production allows for a more in-depth specialisation and broader international networking. The reason for these developments is that different stages of production correspond to different production functions so that a country may have a comparative advantage in one stage of production and a comparative disadvantage in other stages or functions. The business case-studies focus on the geographical splitting-up of activities within ICT companies and identify geographical specialisation in certain business functions.

The main conclusion arising from the case studies is that European companies are increasingly making use of the internationalisation by focussing on high value-added activities. We have found evidence for a geographical splitting up of functions in ICT industries within international ICT companies. When considering the place of the EU in the international division of activities within ICT companies, our main conclusion is that the activities in the EU15 tend to be relatively knowledge intensive, focussing on customisation and high quality. The functions and activities located in Asia tend to be the more standardised and codifiable activities. New Member States take a middle position within this international division of ICT functions.

Chapter VII finally analyses the policy options and makes some main policy conclusions. Some of the main questions that arise include: How should national as well as EU policy makers react to outsourcing of ICT production and certain types of services? Is there a danger that R&D units of European ICT firms are leaving their home countries for Asia? What is the likely impact of internationalisation on the competitiveness of European ICT firms? What further implications does the internationalisation process raise for innovation systems in Europe? Does Europe need a strong ICT industry in order to fully grasp the benefits of this process?

What main lessons can be learned from a policy perspective?

ICT is different from other technologies in several dimensions. Technological change is very fast in ICT. Moreover, ICT is a general purpose technology that induces new innovations in other areas too. Digital goods and services can be transferred at no cost and without time delays. These aspects make the ICT sector an important and crucial sector for economic growth and dynamics.

Internationalisation is a key feature of ICT. Standardizations and codifications allow for highly fragmented production processes so that innovation and production activities can be easily relocated. In this sense, internationalisation should be viewed as a challenge, not as a threat.

EU has stabilised its position in ICT, and improved in some areas. Data show that the production of some products has been relocated in recent years. However, further analysis also shows that mainly less knowledge intensive and more standardized products are relocated whereas more knowledge intensive and customized products and services remain in the EU with some even coming from outside locations to the EU.

Europe needs to continue moving up towards higher knowledge-intensity, quality, and the development of skills. Our analysis shows that the competitive advantages of European firms lie in knowledge intensive goods and services. These strengths must be fostered in order to meet competitive challenges in ICT producing industries. Increased quality of the labour force not only leads to higher quality of output but also to higher productivity levels hence price competitiveness. Moreover, the development of skills is also important to fully grasp the benefits of ICT in user sectors.

ICT is not per definition knowledge intensive. It is important to realize that, mainly due to fast diffusion of knowledge and skills and short lifecycles, many ICT products become more or less standard after a short period of time. In other words, what is considered highly innovative today will be standard tomorrow and outdated next week.

Fostering the responsiveness of institutions and innovation systems to the dynamics of ICT. The ICT sector is highly dynamic with many innovations and very short life cycles. This also implies that policy and the political process should be innovative and flexible too. ICT is not a homogenous sector in terms of standardization and knowledge intensity. However, since ICT generally creates new opportunities for product differentiation, innovation, and accelerated diffusion both within the ICT sector itself and across the overall economy, the ongoing expansion and internationalisation of the ICT sector is crucial for the EU and its member countries.

CHAPTER II. Concepts and Theory

Paul J.J. Welfens and Michael Vogelsang

1 Introduction

1.1 Basic Developments

Information and Communication Technology (ICT) is a core sector of the modern manufacturing industry and trade in goods, but it also concerns IT services and telecommunications services, meaning that the services sector and services trade are also affected. Part of ICT sectors are technology-intensive and knowledge-intensive, but there are certainly some activities which are also characterized by low knowledge-intensive and rather modest skills. The case of call centers is one prime example. At the other end of the spectrum, we find such activities as chip production and advanced software which could be characterized as high technology/high-knowledge intensive. While such a broad classification at the two-digit level of industry (or trade) is adequate, the increasing tendency of the ICT sector to realize considerable fragmentation – that is splitting up the value-added chain – requires adequate differentiation in terms of classification. While the design of a chip or software development is to be characterized by high technology/high knowledge-intensity, the production of wafers or the writing of standard software codes (as part of a complex software package) represents medium technology intensity. From this perspective ICT is, of course, not a homogenous sector.

ICT accounts for a rising share of investment and R&D in OECD countries and is thus of particular relevance for growth, employment, structural change and economic competitiveness. ICT expanded strongly in the 1990s when it became a major driver of growth in the US, the EU and Asia. ICT essentially consists of the three pillars (Eito, 2002, p. 454)

- information technology, including IT services
- telecommunications equipment
- telecommunications services

In terms of markets, ICT is comprised of ICT equipment (hardware for office machines, data processing equipment, data communications equipment, software and IT services), software products, information and carrier services.

The EU countries have completed the transposition of the electronic communications framework of their electronic communications framework into national legislation. Competition has intensified in almost all countries, and the share of broadband e-communication is expanding (European Commission, 2006). In 2005, broadband take-up in the leading EU countries – Netherlands, Denmark, Finland, Sweden and Belgium – was ahead of the US and Japan; other EU countries also have made considerable progress in the expansion of fast digital networks. Broadband expansion is considered by the European Commission as an important element for supporting the Lisbon 2010 goal; the EU has adopted an i2010 initiative in this context, because one expects digital networks to be important for improving European competitiveness. Fixed broadband access lines exceeded 50 million in 2005, and there is indeed considerable growth in the use of broadband communications (see Appendix A).

From an EU25 perspective, it is also crucial to note that the expansion of ICT is associated with the growth of a networked society in which the flow of information and technology on the one hand is accelerating. At the same time, both ICT and digital networking facilitate international outsourcing and offshoring. Offshoring involves foreign direct investment (FDI) while international outsourcing occurs through trade and arm's length market trans-actions.

Many economists have classified ICT as a general purpose technology affecting productivity in almost all sectors, as the use of ICT is associated with considerable technological progress and facilitates innovation dynamics in many sectors (Bresnahan/Trajtenberg (1995)). Lee/Guo (2004) give an overview about its properties by arguing that ICT

- enables complementary organizational investments and coordination, which lead to a productivity increase through reduced costs;
- enables firms to offer new products or services, thus emphasizing the growing role of convenience, timeliness, quality and variety (Brynjolfsson/Hitt (2000));
- induces positive external effects (spillover-effects) and enables positive knowledge spillovers as observed by Romer (1989);
- has seen a large diffusion in different industries and large variations of product offerings.

Hempell (2006) has emphasized that the concept of ICT as an "enabling technology" means that productivity increases are contingent upon adequate company strategies and complementary efforts. This includes an impulse for human capital formation, as skilled labour is complementary to ICT investment. The implication is that the diffusion of ICT will raise the trend growth rate of many countries. In the context of the Lisbon Agenda of the European Community, the growth-enhancing aspect of ICT is quite important. At the same time, one must consider the potential problem that ICT capital accumulation will primarily increase the demand for skilled labour and could thus bring about a relative rise in the skill premium in wages.

The share of high technology imports (with the degree of technological sophistication assumed to correspond to skill intensity) in global imports has increased from 18% in 1992 to 22.4% in 2003 – of which ICT accounted for 12.8% and 17.9%, respectively. The share of medium-high technology trade has remained rather stable at around 37% (Ecfin, 2005, p.63). If one classifies global trade according to factor intensity, one finds that the share of R&D intensive goods has increased in global trade. The share of easy to imitate research goods stood at 14.3% in 1992, increasing to 18.3% in 2003. The share of difficult to imitate research goods was 24.6% in 1992 and 26.2% in 2003.

ICT goods production is – in most subsectors – not only technology intensive; it is also largely scale intensive so that the creation of the (enlarged) EU single market should reinforce the competitiveness of EU firms in this sector. One may measure the change in international competitiveness through the use of regional or global indicators of revealed comparative advantage (RCA). Traditionally the Balassa-Samuelson RCA is used for RCA analysis where the definition of traditional RCA places focus on the sectoral export-import ratio, relative to the aggregate export-import ratio: In this perspective, a ratio above unity indicates a comparative advantage ("positive specialization"). This indicator might be used in a trade-balance corrected form which takes into account any bias related to an aggregate surplus or deficit position (see e.g. Ecfin, 2005). Alternatively one can focus on modified RCA, which is the ratio of sectoral exports to aggregate exports of country i relative to the same ratio for a benchmarking group of countries in the same target market (e.g. EU15 market). This concept was developed by BORBELY (2006), who compares EU accession countries' sectoral export performance within various groups of sectors (e.g., labour intensive or technology intensive) in the EU15 market. Instead of focusing on the EU15 market, one could focus on the world market. Due to data problems, however, the more narrow EU15 single market is often considered.

While it is true that each country naturally is positively specialized in some sectors and negatively specialized in other sectors, one should note that the type of positive specialization is crucial with respect to economic growth, as was shown for the EU15 by the empirical analysis of Jungmittag (2004; 2006):

- If a country is positively specialized in high-technology sectors ("Ricardian specialization") this will significantly contribute to economic growth. As ICT – disregarding some small subsectors – is largely technology-intensive and knowledge-intensive, one should expect that an expansion of ICT will contribute to growth. Internationalisation of ICT through trade, foreign direct investment and international alliances among firms should reinforce high-technology specialization and thus contribute to growth.
- Smithian specialization – this means any specialization –will naturally occur in the process of competition and trade in open economies, but it does not contribute to growth in EU15 countries. One should not rule out that in certain manufacturing sectors import competition could be a particular driver for productivity growth. (For positive evidence with respect to the US but negative in the case of Germany, see Mann, 1998.)
- IT and productivity growth differ across sectors – classified by IT-intensity – as was shown by Mann (2005) with regard to the US: Part of the services sector contributed strongly to productivity (e.g., wholesale trade; security and commodity brokers, depository institutions) while health services and other services contributions have shown low productivity growth – although IT intensity in health services and other services is higher than in retail trade. This intra-services differential raises the question as to whether the structure of the respective sector and market conditions are relevant here. For example, individual services sectors might be subject to different degrees of import competition. Moreover, inadequate government regulations in certain sectors could undermine sectoral productivity growth which raises important policy issues related to the services sector. One should also take into account the fact that sectors differ in terms of the relevance of scale economies and knowledge-intensity.

Sectors which are shaped by low knowledge-intensity and high scale economies will be rather footloose and open to outsourcing so that relocation is rather easy. There will also be strong price competition unless a monopoly exists. Firms in sectors characterized both by high knowledge-intensity and economies of scale generally are more difficult to relocate internationally; quality competition will play a relatively strong role here (e.g., in software or advanced IT services).

- ICT is a sector which is strongly internationalized in ICT goods and – to a lower extent – in ICT services. However, one should also take into account the fact that using ICT (and ICT indeed is a general purpose technology) is facilitating and stimulating internationalisation of non-ICT sectors. ICT facilitates both fragmentation and international outsourcing. There are, however, limitations to outsourcing since the managerial efforts required in a more internationalized and more complex chain of value-added will rise with the degree of internationalisation; this also can be covered through a formal model. To the extent that this general internationalisation effect of ICT expansion contributes to growth and per capita income, ICT growth will be reinforced if the income elasticity of demand in ICT-intensive sectors exceeds unity. In this perspective, there could be twin advantages of (direct and international) ICT internationalisation, and adequate government policies should indeed enhance the benefits through adequate policy measures. There also could be risks of ICT internationalisation which then raise issues for policy makers in terms of cushioning its negative effects.
- ICT foreign direct investment could be asset exploiting (e.g., EU offshoring part of software development to Asia) or asset seeking as it is rather likely to be with many EU investments in the US. With Europe ageing and population stagnating, EU firms can be expected to become increasingly interested in offshoring (outside of Europe) as firms will be interested in being present in growing markets and in regions for which skilled labour is available on a broad basis.
- ICT technology dynamics are not just shaped by innovation efforts in the business community, rather the innovation system is important. EU countries with a proper mix of entrepreneurial dynamics and R&D activities/education should generate favourable dynamics in terms of patenting and foreign direct investment.

The EU Economy 2005 Review (Ecfin, 2005) emphasizes several important developments:

- There is a growing global tendency towards trade in intermediate products and hence to flexible international networked production.
- The EU's trade position is rather weak in ICT, which is considered a high-technology sector: Based on RCA and with respect to the world market, the EU15 has structural deficits in five of the 20 export groups which are growing fastest among the 3-digit product classification groups: In the five negative RCA sectors of the EU15, there are three ICT related industries (semiconductors, computers, parts and accessories for computers) as well as clothing and electrical machinery (Ecfin, 2005, p. 73). East Asian countries – including China and India – have gained considerable market shares in ICT.

- Across all sectors, the EU(15) has lost ground in low and medium-quality products but not in the top-of-the range product groups: At the beginning of the 21st century, upmarket products accounted for 48% of EU15 exports, for 52% of exports in the case of Japan and for 41% of exports in the case of the US (Ecfin, 2005. p. 74)
- ICT is facilitating the international fragmentation of the value-added chain, both in manufacturing industry and in the services sector; the latter thus also raises new challenges for skilled labour (Mann, 2003), which so far has been under rather limited pressure from outsourcing and offshoring. The European Commission notes (Ecfin, 2005, p. 15) that "ICT is affecting production structures: International specialization according to Ricardo's comparative advantage applies increasingly to segments of the product cycle rather than to complete products. The growing share of parts and components in world trade…indicates the increasing fragmentation of manufacturing production. ICT has been a fundamental contributor to the dramatically changed tradability of goods and services…Services are affected: While modularity and fragmentation of manufacturing production is not a new phenomenon, it is now also applied to services. Many jobs previously considered as non-tradable are suddenly exposed to international competition and may risk being dislocated."
- The fact that tradability has increased implies that the costs of international fragmentation have fallen, which has to be further explored in basic models of fragmentation. To the extent that services become more tradable – see the case of digital products and services – one may also expect that economies of scale become more important in the services sector.
- Internationalisation of industries is a consistent phenomenon of economic globalization which mainly means a rising role for both foreign direct investment and international trade, particularly since the expansion of the internet has increased the digital cross-border diffusion of information and knowledge.

Globalization also concerns the aspect that more and more countries have opened up for trade and capital flows, which in turn has facilitated international outsourcing and trade with intermediate products on the one hand and with differentiated final products on the other, the latter being a crucial part of intra-industrial trade. In this perspective the internationalisation of European ICT activities is quite important and raises many challenges for policy makers in EU25 and at the supranational level. As regards the latter, the European Commission has generated important liberalization effects through the opening up of fixed-line telecommunications (network operation and voice telephony) in 1998.

EU eastern enlargement has strongly raised interest in off-shoring – defined as international outsourcing involving foreign direct investment –, as new low-wage countries have entered the EU single market. Assuming that not only cheap unskilled labour in eastern Europe is found but also relatively cheap skilled labour is available in accession countries, one may anticipate considerable pressure for off-shoring. If there is off-shoring through a subsidiary abroad, rising management costs associated with a more complex (international) organization of the respective multinational company must be more than offset by a cost advantage in production or the provision of services – or by improved access to the host country markets. If there is off-shoring to a foreign firm there will be quality uncertainties, so that the cost savings should more than offset the increasing cost of quality verification in the buying of intermediate inputs of uncertain quality.

Policymakers to some extent are worried that international outsourcing could mean considerable job losses. This fear is not only relevant with respect to (ICT) manufacturing but also with respect to services which typically are more skill-intensive than are found in the manufacturing industry. Thus international outsourcing of services could mean that jobs requiring skilled labour (representing relatively high wages and incomes) may be relocated internationally. From an EU25 perspective, there is typically less concern about intra-EU outsourcing than about extra-EU outsourcing. While the former is often considered as a natural element of the single market dynamics, EU international outsourcing is often viewed with scepticism. From an economist's perspective, however, it is fairly obvious that such outsourcing is not principally different from intra-EU outsourcing. This holds all the more as the mirror phenomenon of outsourcing is insourcing: EU trading partner firms outsource to firms in the EU as well, and this is certainly welcome. Taking into account that a considerable share of international outsourcing does indeed improve the global competitiveness of EU firms – say EU software firms outsourcing to Asia so that the cost competitiveness of EU firms in US markets is improved – the basic equation could argue that in a triangular trading perspective, one should not worry about outsourcing. The situation with ICT, however, is special to some extent since the ICT sector is a Schumpeterian sector with high innovation dynamics. Between 15-25% of patents from firms in leading EU countries concern the ICT sector in the early 21st century. Foreign direct investment plays a relatively strong role in technology-intensive sectors so that part of the overall ICT sector will be affected by FDI dynamics.

Foreign investors have always been eager to exploit international relative factor price differentials (here we assume a given desired quality of labour in alternative host countries). High east-west wage differentials in the EU25 on the one hand and high wage differentials between Japan and China suggest considerable potential for FDI. According to Klodt (1993), however, one may emphasize that not all sectors can fully exploit a larger potential for going abroad. In those sectors for which R&D and production are difficult to separate spatially (such as the aerospace sector and specialized machinery), one will find rather limited FDI. Given the fact that airplane markets are politically distorted we still might find considerable FDI, but this would reflect rather the leverage of large markets for which government ownership of airlines is likely to particularly open the door for importing planes from those companies which have agreed to some degree of subcontracting (e.g., Japan, China, India). R&D and production are more easily spread across space in industries which are more footloose. Generally, we may assume that ICT expansion reduces the costs of governance in large MNCs so that FDI is likely to expand. This suggests that ICT reduces the costs of company-internal transactions relative to arms' length transactions in markets, an argument which would be in line with the arguments of Coase (1937) whose approach aims at determining the boundaries of the firm and market. This perspective does not rule out that in certain industries the expansion of ICT rather benefits digital market expansion through the internet. Grossman/Helpman (2002a; 2002b) have presented complex models (without referring to ICT) in which sub-contracting is explained within a general equilibrium model of outsourcing and trade. Outsourcing requires relationship-specific investment governed by incomplete contracts, and the extent of international outsourcing depends in particular on the relative size of transactions costs within a multi-national company as compared to market transactions. Special aspects of IT outsourcing and ICT related services were analyzed by Lacity/Wilcox (2000) and Rubalcaba-Ermejo (2004) and European Foundation for the Improvement of Living and Working Conditions (2004).

This chapter first looks at ICT characteristics and basic findings in the literature and then focuses on the theory of internationalisation; the latter includes the developments of basic models of optimal outsourcing, and the role of outsourcing benefits and costs are highlighted from the perspective of a final product firm. One key aspect is the extent to which the ICT services sector is prone to the same level of off-shoring delocalization as ICT goods. Moreover, we will take a look at the role of final product quality for outsourcing and highlight the role of quality uncertainty on the side of intermediate input producers. In the final section, we draw some conclusions.

1.2 Network Dynamics

The expansion of Information and Communication Technology (ICT) has brought about an enormous modernization of industry through the use of computers and modern software whose use is characterized by network effects. Moreover, there has been a rapid growth of communication networks and – stimulated by increasing competition in the EU after 1998 – falling prices as well as enormous growth of digital product innovations, including many new digital services which are offered through many channels. The internet has come to play an enormous role for private households, firms and governments. The world economy is indeed increasingly shaped by modernized fixed line networks and mobile networks, which allow for the provision of advanced services almost worldwide at the speed of light. However, there are considerable differences across countries, including infrastructure development and the affordability of services/effective utilization (Itu; 2005; Welfens, 2002). Comparing the US and the EU, there are not many differences in fixed line telecommunications, except that the US market is much more integrated than the EU market which, even almost a decade after the liberalization of 1998 suffers from considerably fragmented markets, often with the formerly state-owned monopoly operator dominating. The EU has a lead vis-à-vis the US in the field of mobile telecommunications, however, the US markets have national local calls, meaning call times per month per line are much higher in the US than in Europe.

As regards both Eastern Europe and EU accession countries, there has been considerable mobile network expansion. Mobile density in the Czech Republic – a leader in Eastern Europe – has exceeded that of the EU15 average in the early 21st century. However, fixed-line density is still relatively low in Eastern Europe so that access to the internet is much lower than in EU15 countries. The implication is that internet-based market potential in accession countries is not only lower than in EU countries due to relatively low per capita income, but there is indeed an infrastructure gap which will not be overcome very quickly. Hence the perspectives for accession countries becoming leading exporters of digital services are rather limited as the familiarity with internet services obviously is lower in Eastern Europe than in EU15. With fixed line density in eastern Europe being rather low, the opportunities for fast catching-up in DSL services markets are quite limited.

The strong focus on mobile telecommunications in Eastern Europe is remarkable. In Eastern European EU countries mobile telecommunications – stimulated by a large initial demand overhang and slow reactions on the part of incumbent operators – plays a much larger role than in Western Europe (Ponder/Welfens, 2003). By 2005 mobile communications had become the most innovative field of modern telecommunications in OECD countries, and accession countries will be able to benefit from those Schumpeterian dynamics. However, the rapid growth of DSL fixed line access in EU15 has no parallel in accession countries.

Both telecommunications markets and software markets are characterized by network effects which, on the one hand, amount to an endogenous growth momentum. On the other hand, this reinforces market barriers to entry which are often high in any case since there are considerable sunk costs (e.g., related to high R&D and high marketing expenditures). For Western European countries where the manufacturing industry is facing a gradual relocation to Eastern Europe and Asian countries, the expansion of the services sector is quite crucial in terms of employment and growth. While the Lisbon Agenda – adopted in 2000 with a target date 2010 – has set an ambitious agenda in terms of achieving a dynamic EU knowledge society, the reality at half-time is rather sobering in many EU countries. Only a few EU countries are quite advanced and successful (in macroeconomic terms) in the use of ICT, and the large continental EU countries of Germany, France and Italy do not seem to be leaders in ICT expansion nor in the internationalisation of ICT.

1.3 Conceptual Approach

ICT is not a homogeneous sector, but to a large extent ICT activities are knowledge-intensive. Thus as regards labour markets ICT expansion is expected to raise the demand for skilled labour, while the relative demand for unskilled labour is reduced. The latter implies new challenges for EU countries with high unemployment – typically the share of unskilled labour unemployment is already relatively high.

If one is to understand the impact of ICT expansion more thoroughly, it is useful to analytically split ICT – beyond the standard distinction of ICT goods vs. ICT services – into subsectors, namely in accordance with the relevance of economies of scale and of knowledge-intensity; knowledge-intensity in turn is closely correlated with high technology. This distinction is relevant with respect to the ease with which sectoral value-added – including subgroups within so-called fragmentation dynamics – can be relocated abroad. Using the analytical categories "scale economies" and "knowledge-intensity", we can distinguish between the following four subsectors:

- Innovative scale sectors: production is scale intensive and knowledge-intensive; here global relocation is very difficult except for locational competition between the EU and the US. (For example, a software lab in Europe might lose projects and contracts to competitors in the US. Software indeed is scale intensive in the sense that marginal costs of production effectively is zero.)
- Traditional scale sectors: production is scale intensive and knowledge-extensive; such activity can be relocated rather easily to non-EU countries – and within EU25 from high wage EU15 countries to low wage EU15 countries.
- Traditional Niche Products (including commodified services): provision of such products is not scale intensive and is characterized by low knowledge-intensity. This field of value-added is difficult to relocate in most cases, as the respective service involves immobile service providers and local service users.
- Innovative Niche Products: production is not scale intensive but is knowledge intensive so that relocation from Europe to Asia is not easy as factor endowments in most countries in Asia – with the particular exception of Japan, Korea, Hong Kong and Singapore – are not characterized by high shares of skilled workers which are required in knowledge-intensive production.

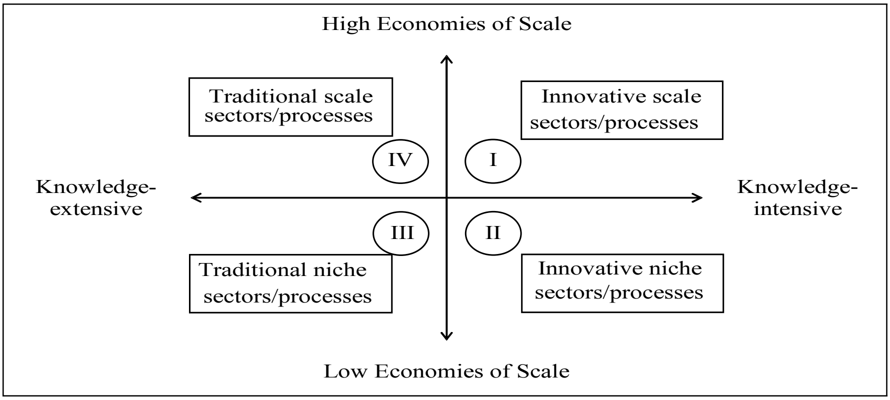


Fig. 1. Types of Goods and Internationalisation

In competitive sectors with high knowledge intensity there is pressure for recovering costs in international markets. Off-shoring (involving FDI) is naturally favoured over outsourcing – that is international sub-contracting – by firms which consider maintaining ownership-specific knowledge advantages as a sensitive issue. As regards economies of scale, one may emphasize that ICT-induced reductions of fixed transportation and communication/transaction costs stimulate internationalisation through both off-shoring and international outsourcing. In certain cases, off-shoring/outsourcing is required by governments of countries with large markets – in particular China. Moreover, ICT goods often involve the outsourcing/off-shoring of intermediate products of low transportation intensity (e.g., in the production of chips which are characterized by both static and dynamic economies of scale); sharp competition in final goods markets indeed forces firms to exploit economies of scale by internationalisation of production. Against this background the following distinction is useful:

The subsequent diagram gives an assignment of some subsectors of ICT to the categories chosen. For instance, we can thus distinguish between customized high knowledge intensity ICT goods (medical/precision/optical instruments), telecommunications, IT services, electronic products, and software. Within advanced software we can make the distinction between packaged software, customized software and own account software. Packaged software is both characterized by economies of scale and by high knowledge intensity, whereas economies of scale are less present in the customized software and absent in the production of own account software. Moreover, one should note that even within packaged software, some processes or functions such as software design and system design are knowledge intensive, whereas actual coding is less knowledge intensive. Electronic products are mainly defined by the high relevance of economies of scale in production; knowledge intensity plays a role in the initial stage of product design. Customized high technology ICT goods are characterized by high knowledge intensity as are telecommunications and IT services.

Knowledge-Intensity / Economics of Scale	
Packaged Software* +/++ Customized Software +/+ Own Account Software +/0	Electronic Products: with Respect to Design ++/0 in Production 0/++
Customized High technology ICT Goods ++/0	IT services +/0 Telecommunications* +/+

* also has network effects = endogenous growth of demand

Fig. 2. Selected Sub-ICT Sectors (Position in Terms of Knowledge Intensiveness/ Relevance of Scale Economies)

The type of distinction made here is useful, as it has implications for the prevailing type of competition: The higher knowledge intensity is, the less footloose the respective activity, namely in the sense that relocation from the EU towards Asia, for example, cannot easily take place. Telecommunications and IT services are also largely knowledge-intensive, but economies of scale do not play a big role. Rather network effects on the demand side are important so that the size of the market is an advantage. From this perspective, creation of the single EU market and EU-inspired sectoral opening up after 1998 is a crucial advantage for Europe.

Comparing the ICT sector – this sector is not a homogenous sector since one finds many high-technology activities, but also medium-technology and low-technology activities – to non-ICT sectors, the two crucial differences emphasized here concern aspects of knowledge-intensity and scale effects. Closely linked to the knowledge-intensity aspect is the complementary skill-intensity. The skill-intensity of the workforce available in regions or countries matters with respect to outsourcing options. From a theoretical perspective, the basic difference between national outsourcing and international outsourcing is the fact that only in an international perspective do relative factor price differentials exist (often related to relative factor endowments); by contrast, national outsourcing takes place within uniform factor prices in a given country.

In knowledge-intensive industries, quality competition plays a considerable role. This does not, of course, rule out that prices could fall over time, namely if there is a high rate of process innovations or if there are network effects in combination with economies of scale. Knowledge-extensive products with high economies of scale will be subject to strong international price competition where rapidly falling prices imply potential downward pressure on wages in the respective sector. By contrast, electronic products with strong economies of scale in production will be subject to globalization in the sense that at each stage of the product cycle there will be pressure to move production to those countries which have production cost advantages, in particular labour cost advantages. Software – and digital goods – have certain special aspects; software represents a combination of huge economies of scale, knowledge-intensive "production" and on top positive network effects; thus, the usefulness of the first users rises as other others also adopt the respective software.

The internationalisation of ICT has been a common phenomenon in OECD countries (as well as NICs) and goes through several routes. Trade in computers and other equipment is one element, foreign direct investment in the ICT sector another. ICT goods are technology intensive, while ICT services are knowledge-intensive. Both trade and foreign direct investment in services are increasingly important but difficult to fully describe and analyze. Within the overall fields of services, the telecommunications sector has become a key field of both increasing trade and foreign direct investment activities after the liberalization of telecommunications in the EU in 1998.

The internationalisation of ICT is crucial not only with respect to productivity growth but also with respect to trade and employment. As regards the latter, one should make an important distinction:

- unskilled labour – the specific unemployment rates were relatively high in both continental EU countries and in eastern European accession countries at the beginning of the 21st century;
- skilled labour, which is particularly important in the production of high-technology goods and differentiated products on the one hand and services on the other.

Services have dominated output in EU countries and other leading OECD countries at the beginning of the 21st century. However, international trade is rather low as it accounts for only about 20% of overall global trade (WTO, 2005). Trade in services for consumers or companies and services as an intermediate product for firms are obviously not as easy to provide across borders as are goods. While it is true that outsourcing can, in principle, be within a country or international, one may infer that the low share of services in overall trade points to specific problems with respect to trade in services. We can broadly distinguish between four kinds of services:

- private services provided for firms which in turn can be in manufacturing or in the services sector;
- public services provided for firms (e.g., copyrights/intellectual property rights and military protection of property in firms)
- private services provided to private households
- public services provided for private households (e.g., the education system, part of the health care system)

Public services may be outsourced, but this is done mostly within a given country. For politico-economic reasons, many government services which could be outsourced are not outsourced at all. International outsourcing of public services is quite rare. One should add that the rules and the spirit of the EU single market call for free trade in services in the Community. However, in reality it still is true that government-owned firms have a rather weak tendency to outsource internationally and also a weak tendency to engage in the exporting of services; this suggests benefits with respect to privatization.

As regards outsourcing and offshoring we may distinguish between (EU, 2005; see Table 1 below):

- domestic outsourcing (other firms in the country considered supply inputs)
- international outsourcing (non-affiliated firms abroad supply inputs)
- offshoring (foreign-based affiliates are suppliers)
- domestic in-house production (firm produces value-added at home; within the firm)

Other authors differentiate between internal (or captive) offshoring and offshore outsourcing (see OECD (2004c) for example). However, these distinctions only become relevant when analyzing the behaviour of multinational companies. The expansion of ICT has generally reinforced national and international outsourcing opportunities, since the use of ICT has stimulated standardization and also often requires digitization. International outsourcing and offshoring not only concern ICT goods but ICT services as well. To the extent that the provider of the service or the user of the service is internationally mobile, there are considerable opportunities for international outsourcing and offshoring. In the case of international outsourcing there can be ambiguous income and employment effects and negative effects on the current account of the home country (I); the income effect is likely to be negative although one cannot rule out that product upgrading in country I – linked with international outsourcing – will generate a positive net income effect and possibly also a net employment effect. As regards the latter, however, one may anticipate an increase in the demand for skilled labour and a fall in the relative demand for unskilled labour so that unemployment among unskilled workers is likely if there is insufficient nominal and real wage flexibility. Boes (2005) points out that purely IT service companies prefer internal offshoring. From an economic point of view, however, both internal offshoring and international outsourcing imply the importing of intermediates (services) as is stressed in the fragmentation literature (see Jones/Kierzkowski (2001) and Deardorff (2001) for example).

Table 1. Classification of Outsourcing, Offshoring and Home Production

		Ownership of activities	
		Internal to the firm	**External to the firm**
Location of activities	**Home**	*Domestic in-house production* (firm produces its products domestically without any outside contracts)	*Domestic outsourcing* (firm uses inputs supplied by another domestically-based company)
	Overseas	*Offshoring* (firm uses inputs supplied by its foreign-based affiliates)	*International outsourcing* (firm uses inputs supplied by an unaffiliated foreign-based company)

Source: Commission Services, EU (2005)

Adopting the transactions cost theory, international outsourcing is more suitable the more standardized and structured the services are. International IT outsourcing brings with it the same advantages and risks as domestic IT outsourcing, but the amplitude may be larger due to higher differences in labour costs: According to Allweyer et al. (2004), a high quality software developer earns 120 to 200 Euros a day in India, whereas in Germany the daily rate is 600 to 1000 Euros. This cost-orientated international outsourcing may lead to the effect that the value added measured on a company level rises whereas the 'value added' on a country level shrinks. A special reason for offshoring also presents itself when international IT resources are needed for an international expansion. This may concern the availability of language capabilities in special time zones (e.g., for a call-centre) or IT support for foreign affiliates.

An OECD report (2004c) emphasizes the inherent dynamic of international outsourcing, namely that 'competition has created a self-reinforcing dynamic.' It argues that an initial international outsourcing activity leads to further international outsourcing. Internal offshoring (within a multinational company) provides the confidence necessary to begin with international outsourcing.

Internationalisation can be through trade, foreign direct investment and licensing (including cross-licensing). There is a potential for rising trade to the extent that ICT facilitates product differentiation. To the extent that ICT contributes to productivity growth and higher per capita income, the demand for differentiated products will increase. Foreign direct investment should play a particular role in technology-intensive/knowledge-intensive sectors as is argued in the standard literature. In a networked world economy, outsourcing and offshoring can potentially take place with respect to elements in the value-added-chain. This fragmentation phenomenon became increasingly important in some sectors in the 1990s. Moreover, we have to take into account life-cycle theory in the sense that product innovations imply absence of economies of scale and hence an emphasis on quality competition: with standardization progressing in the life cycle and hence marginal knowledge requirements falling the scope for internationalisation will increase. To the extent that there is intra-EU outsourcing/offshoring there should be no mayor problems from the perspective of the Union. It is clear that value-added in sectors of low knowledge-intensity are likely to be relocated to extra-EU countries in many cases – often this will affect unskilled labour in the EU so that retraining and education become key challenges in the digital age in Europe. As regards knowledge-intensive high-technology sectors, the EU could indeed be on the winning-side since there is not only international outsourcing/offshoring (which could be to the US as a country richly endowed with human capital and R&D capital) but also insourcing/inshoring.

The international division of labour in both Europe and the world economy will naturally show that the EU15 (or EU10 or EU25) has a positive revealed comparative advantage – that is a sectoral strength in terms of the relative export position – in some sectors and a negative RCA in other sectors. Having an advantage in high technology sectors is a special asset for a country since this amounts to high technology specialization which in turn stimulates economic growth. Thus a positive RCA in key ICT sectors is indeed desirable since ICT largely represents high-technology goods and advanced services.

In terms of economic growth ICT trade can contribute both on the export side and the import side to growth. Exporting could mean impulses towards high-technology specialization which supports economic growth. Importing ICT goods to some extent could reinforce the high technology specialization. At the same time, one should consider that growing imports of certain ICT-intensive goods imply that knowledge from abroad – embedded in the intermediate products imported – is flowing into the economy and effectively adding to the growth rate of technological progress. International technology transfer can also take place in a two-way direction through international alliances among ICT firms. Considering technology dynamics and specialization, it is important to focus on RCAs and on patenting patterns; the latter also has implications for potential cross-licensing. Since international technology transfer is strongly linked to foreign direct investment as well, it will be important to analyze the relative inflow of such investment in EU countries. As regards EU offshoring dynamics, it is also relevant to focus on foreign direct investment outflows: According to standard approaches in Economics, high outflows should, on the one hand, reflect ownership specific (technological) advantages of the respective firms. On the other hand, they should reflect relatively attractive locational conditions for foreign firms abroad and advantages for organizing international transactions within the multinational firm. As ICT is largely technology intensive, high foreign direct investment dynamics in this sector should be expected.

ICT generally facilitates international outsourcing and offshoring (the latter involving foreign investment). Digital international networking within multinational firms and cutting via international outsourcing are crucial elements of economic integration and globalization. In a dynamic perspective, there will be a change in the intra-EU international division of labour and also in the global division of labour. ICT affects trade, foreign direct investment and the building of international alliances. In those subsectors for which ICT is high-technology based, international alliances play a considerable role. (For instance, patent citation analysis can reveal some of the international knowledge flows which largely are not revealed by patent analysis.)

ICT is characterized in both the field of hardware and software through declining relative prices which implies that the share of ICT investment in overall investment will increase. This aspect in combination with static and dynamic economies of scale effects in ICT production and network effects – quasi-automatic "endogenous" demand growth – imply considerable opportunities for (endogenous) growth. Technological dynamics and growth dynamics create opportunities for sustained growth. Hence, innovation policy/growth policy represents a very important challenge in the EU.

Not all ICT is high-technology in the traditional sense, namely that R&D expenditures exceed 8.5% of sales. One may distinguish between electronic products which are largely high-technology intensive, telecommunications which is medium-technology as well as human-capital intensive, software which is mainly knowledge-intensive and IT services which are knowledge intensive as well. As regards the potential for international relocation of industry, the value-added chain of electronic products could almost fully be subject to globalization in the sense of offshoring (producing in subsidiaries abroad) and outsourcing (buying intermediate inputs from firms abroad). Relocation of manufacturing is rather common in the electronics industry. For example, strong competition in mobile telecommunications markets forces US and EU firms to subcontract manufacturing of mobile handsets to Asian countries. Yet R&D cannot easily be relocated globally with relocation occurring mainly within OECD countries. However, one should not overlook that ICT facilitates internationally-networked R&D so that an important challenge for EU countries is that part of R&D activities might be relocated outside the EU. European firms undertaking R&D in the US – involving asset-seeking foreign direct investment – are a standard phenomenon, but there are new tendencies that part of R&D is relocated to Asia, in particular to China (e.g., SAP Labs in Bangalore and Shanghai; Nokia reducing R&D activities in the EU and establishing a new R&D facility in China).

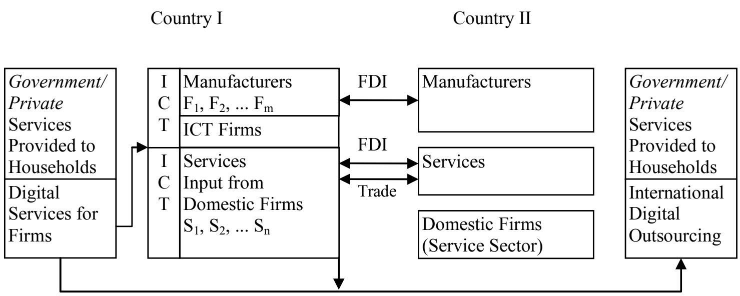


Fig. 3. Internationalisation of Services in the Context of ICT

In a broader theoretical perspective (see the figure above), the challenge is to understand the dynamics of the provision of private or government services to sectors using ICT – including ICT producing firms – and to explain the patterns of international digital outsourcing in combination with two-way foreign direct investment and trade. Besides international outsourcing there can also be international insourcing which implies two-way trade in services. Digitization and global networks/the internet have been important in effectively increasing the mobility of service providers and users. The switch to broadband transmission brings with it a new quality for digital trade and internet-based cooperation in research.

In the OECD countries, there is considerable political sensitivity with respect to international services outsourcing for several reasons:

- Services are labour intensive, raising fears about job losses in particular in countries with high unemployment.
- At the same time, there is concern that well-paid service jobs might be outsourced internationally so that real income losses could occur through both job losses and a general downward wage pressure for skilled services.
- As regards the EU, intra-EU outsourcing should not be considered a problem at all since this is a natural element of the EU single market. If there is extra-EU outsourcing, policymakers are likely to be more sensitive about the outsourcing of services, not in the least due to the relatively labour-intensive nature of most services so that sustained extra-EU services outsourcing could entail a high number of job losses. Therefore it would be desirable to have a split in outsourcing with respect to the intra-EU outsourcing of services (and material inputs). While individual countries facing outsourcing might be transitory losers from intra-EU outsourcing in terms of employment or value-added, the overall EU should benefit economically from outsourcing in the medium term – that is after adjustment in the firms and sectors involved has been completed.

Service outsourcing can hardly be discussed without taking a look at the particular role of multinational companies:

- In source countries of foreign direct investment, one should expect that the headquarters of the respective multinational companies will provide a whole range of services to foreign subsidiaries.
- Conversely, countries which are major host countries of foreign direct investment will record relatively high imports of intra-company services. We therefore expect a high correlation between international outsourcing and foreign direct investment patterns.

In the subsequent analysis, we will focus on elements that stimulate services and trade in services. One must also consider key impediments to trade in services on the one hand, while analyzing the extent to which modern Information and Communication Technology reinforces or undermines trade in services. Moreover, we are interested in understanding the degree to which foreign investment (FDI) in the services sector poses special opportunities or problems in EU countries and the OECD world – or the world economy. It is remarkable that the growth rate of services FDI exceeded that of the manufacturing industry in the 1990s. This simply might reflect an offset to the problem that trade in services faces systematic problems, so that the provision of services abroad is a natural development in a world economy in which – after 1985 – multinational companies in manufacturing have increasingly invested abroad. Firms from EU countries that are interested in using similar quality services as intermediate inputs abroad as are used in the home country are a magnet to complementary services providers which therefore invest abroad.

One may consider three links of internationalisation (plus migration):

- Trade (horizontal or vertical)
- Foreign direct investment – this particularly includes not only selling a company – or specific activities of it – to an industrial investor. Rather one must also consider the option of selling activities to an international financial investor group. (This was one of the options considered by Philips management with respect to its ship production segment in 2006, for instance.)
- International licensing and R&D cooperation across borders

Thus one is interested in two key questions: (i) understanding to which extent ICT stimulates trade, foreign direct investment and innovation/R&D activities; (ii) analyzing specific innovation aspects of the internationalisation of ICT including R&D.

While the outsourcing of material inputs is an old phenomenon of the division of labour in manufacturing industry, the outsourcing of services is a more recent development. To some extent it should be reinforced by the growing share of services output in overall output in wealthy OECD countries. This phenomenon is likely to reflect an income elasticity of the demand for services above unity and is also linked to the move towards an affluent leisure society; "affluent" means that savings are relatively high compared to income so that financial services naturally play a considerable role in the economy and growing leisure time implies a rising demand for personal services. Here the internet signifies a totally new platform which can be quite relevant in this field. Moreover, with rising per capita income there is an increasing demand for differentiated products which in turn requires sophisticated and flexible services at various points of the value-added chain (e.g., design, production, shipping and distribution). In like manner, after-sales services are often quite important.

A remarkable feature of the discussions about the New Economy and globalization has been the belief on the part of many consultants that many thousands of highly paid IT jobs are bound to be lost in the US and Europe as new outsourcing options arise in India and other countries. At the same time, both the US and many EU countries are major exporters of "digital services", with the latter amounting to insourcing. This leads to the question of digital outsourcing on the one hand and digital insourcing on the other.

The EU is a major player in the global ICT sector and is strong in both software and hardware, maintaining a certain digital strength and reinforcing ICT competitiveness since ICT contributes to higher output and productivity growth. As wages in several EU countries are higher than in the US, it would not be surprising to witness sustained digital outsourcing with part of the outsourcing activities concerning eastern Europe and the former Soviet Union. Since the economic opening up in 1990/91, this represents a new geographically proximate potential target area for EU firms seeking to find skilled labour and researchers in software and computer sciences.

Given the fact that EU eastern enlargement will go along with the relocation of many industrial firms' plants from EU15 to eastern European accession countries – and beyond –, one should emphasize that for Western Europe an adequate exploitation of the opportunities from growing services trade is crucial. While ICT investment can raise productivity in all EU countries, one must anticipate that ICT facilitates international outsourcing. One may expect that the manufacturing industry – which is relatively footloose – will pursue a relatively fast internationalisation process in the EU25 single market. The services sector might be proceed forward more slowly for various reasons. However, wage costs in the IT services sector are relatively high so that high international wage differentials naturally stimulate the internationalisation of the IT business. To the extent that many IT projects require close collaboration in the context of face-to-face contacts between company representatives and experts from IT service firms, the geographical location of MNC headquarters will strongly influence the patterns of IT services trade. At the same time, economic reforms in Eastern Europe and special IT promotion through governments – including human capital formation – in India and many other Asian countries are likely to reshape the global supply side of services.

Since the WTO created a basic framework within GATS in the mid-1990s, there is also a set of rules available which facilitates international trade in services. Trade in services, having traditionally been rather underdeveloped compared to its share in output in OECD countries in the second half of the 19th century, is likely to expand with high growth rates in the medium and long run. The internet provides new opportunities for digital services growth; new expanding companies such as Google, Yahoo and Ebay provide evidence for this. The ongoing fall of relative hardware prices stimulates the computerization of the economy and increase demand for software.

1.4 ICT Market Dynamics, Outsourcing and Offshoring

There was a strong expansion of ICT in the US in the 1990s – as is visible from the doubling of the US share of ICT in value-added, reaching about 10% in 2001 – and a similarly strong expansion in the EU. Not only have production and trade in hardware strongly increased, trade in digital services has also grown considerably; in the EU, this has occurred very strongly in telecommunications in the post-1998 liberalized EU framework. Market opening up in telecommunications and the privatization of telecommunications brought about a mutual invasion of EU markets through foreign investors as well as increasing trade in international services, namely to the extent that services trade should depend relatively strongly on international telecommunications costs. International telecommunications costs have fallen enormously. This is not only due to intensified competition in the telecommunications services sector narrowly defined, but also due to a high rate of process innovations in the ICT sector. As regards the EU, the trade balance in the period 2001-03 has been negative with respect to extra-EU trade, but the deficit has reduced over time, partly reflecting weak demand in the Community. EU markets account for roughly 34% of the global market, slightly smaller than the US market. International ICT markets are large and market growth has been relatively high – around 4% – in the years after 2004 as the following table of EITO shows.

Table 2. EU-15 Trade in ICT Hardware, € Thousand

EU 15	2001	2002	2003
Imports intra-EU 15	98.067.172	76.527.811	57.286.880
Imports extra-EU 15	81.876.448	69.936.590	48.767.994
Imports total	179.943.620	146.464.402	106.054.874
Exports intra-EU 15	103.804.701	81.727.938	53.192.408
Exports extra-EU 15	48.478.823	39.314.750	20.334.517
Exports total	152.283.523	121.042.689	73.526.925
Extra-EU 15 / intra-EU 15 exports	46,7%	48,1%	38,2%
Extra-EU 15 / intra-EU 15 imports	83,5%	91,4%	85,1%
Trade balance	-27.660.096	-25.421.713	-32.527.950
Extra-EU trade balance	-33.397.625	-30.621.840	-28.433.477

Source: European Information Technology Observatory (2005), p. 259

Table 3. Worldwide IT Market Growth Trends (Market Value in Million at Constant 2003 Exchange Rates)

€ million	2002	2003	2004	2005	2006
Europe	292,761	288,339	297,104	310,542	324,527
US	325,204	326,435	340,077	355,039	373,909
Japan	127,611	126,985	129,362	132,502	136,466
Rest of World	105,027	108,784	113,649	119,332	126,99
Total	850,602	850,543	880,192	917,397	961,892
			% breakdown		
Europe	34,4	33,9	33,8	33,8	33,7
US	38,2	38,4	38,6	38,7	38,9
Japan	15,0	14,9	14,7	14,4	14,2
Rest of World	12,3	12,8	12,9	13,0	13,2
Total	100,0	100,0	100,0	100,0	100,0
			% growth		
Europe	-3,0	-1,5	3,0	4,5	4,5
US	-6,3	0,4	4,2	4,4	5,3
Japan	-0,8	-0,5	1,9	2,4	3,0
Rest of World	1,7	3,6	4,5	5,0	6,4
Total	-3,6	0,0	3,5	4,2	4,9

Source: European Information Technology Observatory (2005), p. 211

Basic Theoretical Perspectives on Outsourcing and Offshoring

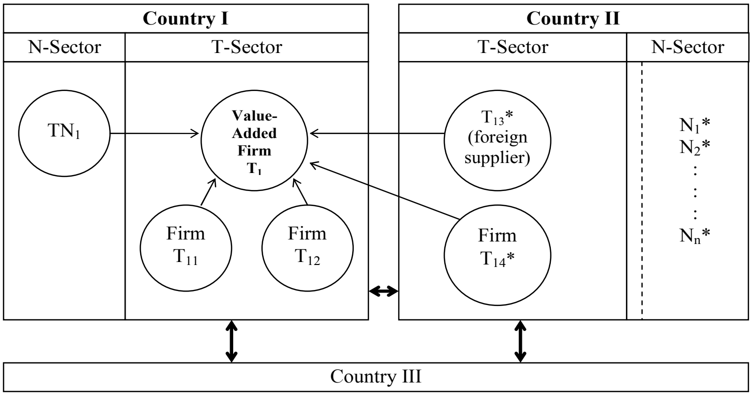
ICT facilitates national and international outsourcing (Welfens, 2006b) while also raising the range of tradability in the services sector. The nontradables N-sector shrinks (see the figure: dashed line in country II) while the tradables T-sector grows. The firm T_1 considered in country I can outsource tradable goods and services domestically – say to firms T_{11} and T_{12} – or to the domestic N-sector. Domestic outsourcing typically takes place within nationally uniform factor prices. National outsourcing will occur in particular in three cases:

- growth of production leads to a situation in which minimum optimum plant scale is exceeded;
- at the present production site there is lack of critical input factors (e.g., skilled labor) so that outsourcing to other regions – relatively well-endowed with the respective production factor – will occur;
- better access to customers (or greater proximity to regional or local demand) is often a reason for setting up regional subsidiaries (e.g., in the case of business software services).

A specificity of ICT both with respect to national outsourcing and international outsourcing is the fact that ICT potentially allows flexible and fast fragmentation. As regards international outsourcing and offshoring, this implies that individual EU countries could lose value-added at some point in some specific activities of the ICT sector. However, the overall EU25 perspective could be rather favourable in the sense that intra-EU outsourcing or relocation within the EU25 is a normal element of single market dynamics. To the extent that this improves competitiveness of EU ICT producers in global markets, this is a welcome element of supply-side dynamics.

National outsourcing is partly explained through aspects related to minimum optimum plant scale and local availability of production factors intensively used in the respective ICT activity (note that within the country, factor prices are identical). From a theoretical perspective, the split between national and international outsourcing can basically be explained both through relative factor endowments and factor price differentials. As regards intermediate tradables there is potential competition with suppliers abroad; the split between outsourcing to domestic suppliers and foreign suppliers will typically be determined along the lines of the Heckscher-Ohlin-Samuelson approach. As countries I and II will differ in terms of relative factor endowment, international outsourcing will be favored with respect to those components which use the factors intensively which are relatively abundant in country II. (For example, as Hungary is known to be relatively well endowed with software developers, international outsourcing and offshoring in the software sector can be expected to go to that country in many cases.) Note also that the international expansion of ICT amounts to a shrinking of the nontradables sector, since ICT facilitates international trade of services in many fields – see the dashed line (Fig. 4) in country II which for ease of exposition is assumed to face this development first.

(T is tradables sector; N is nontradables sector)



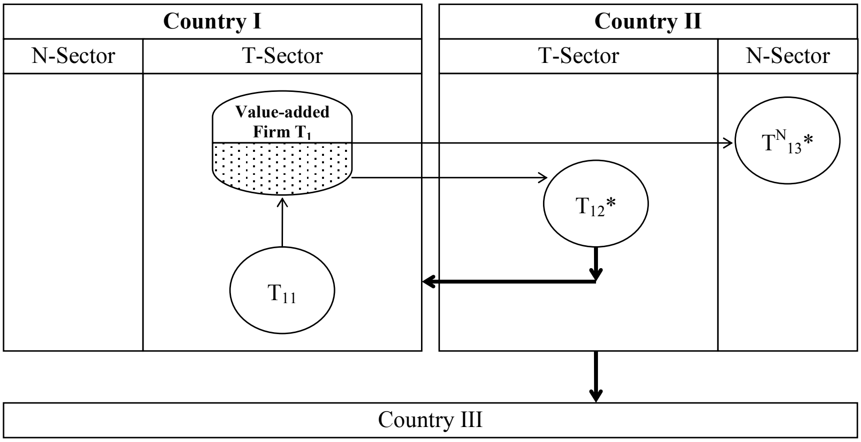
Source: Welfens (2006b)

Fig. 4. National and International Outsourcing / Fragmentation of ICT Production

A large share of ICT is strongly technology intensive, and international outsourcing is therefore often in the form of offshoring. Offshoring allows not only for cutting costs by importing from foreign subsidiaries in the tradables sector. In principle – and ignoring aspects related to the domestic N-sector – there is also the option that ICT offshoring takes place in the foreign non-tradables sector (case of special ICT services). Intermediate inputs from foreign subsidiaries goes into production of firm T_1 in country I, see Fig. 5. However, part of valued-added in foreign subsidiaries could be sold directly in the world market (country III). As the R&D intensity of ICT is expected to grow over time, one should expect that offshoring will gain in importance in the long run.

In some ICT sectors, network effects are relevant, to the extent that international outsourcing dynamics could be affected. From a theoretical perspective, international network effects are of particular relevance in ICT innovations in certain fields. Network effects are positive demand-side externalities, which are rather unusual. ICT R&D is likely to have positive cross-sector spillover effects. One may also anticipate considerable international spillovers, either in the ICT sector itself or through increasing use of ICT capital in other sectors. One should, however, carefully distinguish between sub-sectors of ICT. For example, chip production is scale intensive and knowledge intensive (referring to the overall product not the rather simple chip production as such) as is software. However, many digital services must be very customer specific so that economies of scale play a limited role. To some extent, economies of scale can be exploited for the basic product – say the core algorithm – while customization requires specific adjustment involving the employment of skilled labor.

(including direction of sales from subsidiary (bold arrows))



Source: Welfens (2006b)

Fig. 5. ICT and International Offshoring Opportunities

While ICT facilitates international outsourcing, it is not true that leading OECD countries are natural losers from outsourcing. Indeed, international outsourcing can stimulate structural adjustment in a way which increases productivity, competitiveness and growth. Moreover, international outsourcing from the EU to Eastern Europe, Asia and the like goes along with insourcing in the sense that firms from Asia and other regions of the world economy can conquer markets in EU countries/OECD countries only if they set up marketing centers and R&D facilities in those countries (which have a comparative advantage in relevant R&D fields). An important study in this context refers to outsourcing of US software development activities: Bailey/Lawrence (2005) have shown that the US software sector internationally outsourced some 100,000 jobs in the period from 2000 to 2003. However, the overall number of software personnel in the US increased in that period. Mostly, rather simple programming jobs were outsourced, often to Asian countries. This suggests that international outsourcing of standardized services will provide advanced countries with a relative abundance of skilled workers to specialize increasingly in advanced services. The EU15 should benefit in a similar way, as leading software firms become more globally competitive by outsourcing to Eastern Europe or Asia.

To which extent is offshoring in ICT more likely than in other industries? Following Dunning's OLI-paradigm (ownership-location-internationalisation approach), the fact that ICT – broadly defined –represents the top innovators among all sectors in the EU, one should indeed expect considerable FDI activities. Technological advantages represent ownership specific advantages which are a critical basis for successfully producing abroad. Countries which offer locational advantages crucial for ICT will be winners in the quest for attracting ICT foreign investment flows. Besides market size, one should emphasize the role of the availability of skilled labor and a successful innovation track record (market size will be crucial in the case of economies of scale activities) with respect to knowledge-intensive ICT. Standardized digital services (e.g., call centers) for which outsourcing can go to countries with advantages in terms of language skills and low wage costs of unskilled labor are the typical exceptions.

The fact that EU-driven liberalization of telecommunications markets has brought about a particularly strong fall in international telecommunications prices has clearly favored international outsourcing in the case of many digital services. If VoIP-telephony should become more common, this phenomenon will further intensify.

A Microeconomic Perspective: Optimum Fragmentation in a Simple Model

ICT reduces the cost of international management. At the same time, ICT facilitates product differentiation and therefore creates a tendency to sell more valuable products. These two aspects play a role in the subsequent analysis. If a firm (producing a quantity of final product q) relies on intermediate suppliers, it must have an advantage from outsourcing to N' firms. This can be modeled rather simple (Welfens, 2006). As regards suppliers N' let us assume that costs (C) of intermediate inputs plus production are given by two terms where the first right-hand term expresses procurement plus direct management costs at the final goods producer and the second term stands for network management costs and network effects in the group of suppliers (the network effect is assumed to be appropriated by the final goods producer; this effect is the second right-hand term in equation i):

(i) $C = N'^2 + b'/N'$

Let us assume that the quantity q produced in the final product firm depends on the supply of intermediate products N' in the following way:

(ii) $q = bN'$

Consumers are willing to pay more for sophisticated products – and by assumption consumers take the number of suppliers as a proxy for sophistication - so that the implicit demand curve is given (using y to denote per capita income; p', b'' and p'' are positive parameters) $p = p'N' + b''y$; furthermore we assume that a higher per capita income is positively correlated with the number of supplier firms, and hence we state $y = p''N'$. Profits И for the firm which is assumed to be a price-taker in the market are thus

(iii) $И = pq - C$

(iv) $И = p'bN'^2 + bb''p''N'^2 - N'^2 - b'/N'$

Thus the optimum degree of fragmentation is – assuming that $p'b + bb''p'' < 1$ - obtained from

(v) $dИ/dN' = 2(p'b + bb''p'' - 1)N' + b'/N'^2 = 0$

Thus the necessary condition for profit maximization is given by setting the number of supplier firms to:

(vi) $N'\# = [b'/2(1 - p'b - bb''p'')]^{1/3}$

The optimum degree of fragmentation is a positive function of the network supplier parameter b'. To the extent that ICT expansion reinforces network effects among suppliers – in particular in the ICT sector itself – there will be reduced outsourcing: Each (remaining) supplier firm will provide more intermediate inputs. Moreover, as we can see the optimum N' is a positive function of the parameters p', b, b", p"; as regards the impact of b it is not surprising that a rising productivity of using intermediate inputs raises the optimum number of suppliers. To the extent that the price is positively influenced by the presence of intermediate product suppliers (see the parameters p', b", p") the optimum degree of outsourcing is raised. Of particular interest is the parameter p' since it suggests that more complex investment goods and consumer goods – in high demand in a knowledge society – will be characterized by more outsourcing. At this point we have to add some reflection on the split between international outsoucing and domestic outsourcing. An important question is technological heterogeneity among suppliers across countries; and international factor price differentials have to be considered. In an open economy model one may assume that in case of international factor price differences there will be outsourcing in favour of that low-wage country where suppliers match the knowledge required to build the respective component (e.g. as regards software engineers there are considerable international factor price differentials; see appendix).

As regards domestic vs. international outsourcing, one also may consider the assumption that international outsourcing is associated with additional quality uncertainty compared to the home country. Quality uncertainty is more relevant for technology-intensively produced goods than for simple standardized goods, and FDI can be a way to make sure that product quality problems will not occur abroad (while the firm still can exploit cost cutting opportunities from producing abroad). From this perspective international outsourcing combined with foreign direct investment – that is offshoring – should be important in technology-intensive sectors; this argument obviously then is relevant for that part of the ICT-sector which is technology-intensive. Moreover, the drive to exploit such offshoring opportunities is reinforced through the presence of scale economies since scale economies allows spreading R&D costs over larger production runs.

However, if one basically follows the OLI approach of Dunning (195, 1972, 1973, and 1977), we should expect offshoring to play a particular role in high-technology industries since there are considerable market imperfections in international technology markets. We would have to modify the model by not only considering expected coordination costs but also the risk of illegal international technology transfer. If the risk of technology to be siphoned off in the context of vertical outsourcing and trade relations exceeds a critical threshold, offshoring will dominate international outsourcing; relying on transaction with affiliated companies abroad will minimize the risk of illegal technology transfer. Whether skilled labour will benefit more than unskilled labour is an open question.

Model of Horizontal Digital Offshoring

An important element of modern economic globalization is digital international offshoring; Information and Communication Technology plays a particular role in this respect, not least because international transfer of knowledge is relevant in the ICT sector and in ICT using-sectors (the ICT sector itself is among the top sectors using ICT technology and complementary human capital intensively). To better understand the international economic dynamics let us consider a simple and useful model, namely a firm which is active in an asymmetric two-country world where country I, the home country, is assumed to be the technologically leading economy. In the relatively poor country II the nominal wage is lower than in country I; and the level of technology in country II (A*) is lower than in country I (A). The firm is considering production in the home country (country I) and abroad (country II), namely in a setup where the use of technology (A) and employment of knowledge workers (L) in the firm in country I generates positive productivity spillovers for the corresponding firm abroad (Welfens, 2006). The strategic decision of the firm concerning how much to produce in country I and country II, respectively, is considered subsequently in more detail. Note that for simplicity we first ignore fixed costs of international offshoring – fixed costs (effectively representing ICT capital/software) will affect profits but not the international allocation of ressources. In a simplified model we can state the basic decision-making problem as follows: We assume that the firm can be represented by production functions at home and abroad and has as direct inputs on the firm's side only labour L and L* (* denotes a foreign variable), respectively. Moreover, there are also inputs in the respective production site in the form of A and A*, which initially are national spillover effects to the firm/production site. Nominal wages rates W in country I and W* in country II are given. The representative firm maximizes profits И with respect to L and L* while taking into account that the production function in country I is F(A, L) and in country II it is F*(A*, L, L*). Using a fairly general statement of the problem, we assume that the share σ of output sold in country I is a positive function of L/L*; the large multinational company considered is aware that higher employment in the home country will raise the share of output sold in country I. Assuming that the firm's home output F=Af(L) and that F* =A*f*(L*,L) – we will later consider the aspect of technology catching-up which relates A* to A or other variables – we can state (with p denoting the price in country I, σ the share of output sold in country I and e the exogenous nominal exchange rate) that the profits to be maximized are given as:

$$\text{(I)}\quad И=p\sigma(L/L^*)[Af(L)+A^*f^*(L^*,L)]+ep^*[1-\sigma(L/L^*)][Af(L)+A^*f^*(L^*,L)]-WL - eW^*L^*$$

Let us take a look at the case of fully integrated markets which implies p=ep*; we assume that eW*=αW (0<α<1). The optimum employment of L and L* – assuming for f(L) and f(L,L*) positive partial derivatives ($\partial f/\partial L=: f_L$) and declining marginal products – is given by the two necessary conditions related to dИ/dL=0 (equation II) and d И/dL*=0 (equation IV):

$$\text{(II)}\quad Af_L + A^*f^*_L = W/p$$

The product wage W/P must be equal to the marginal product of labour L in country I plus the international firm-internal spillover effect, namely the marginal product of labour L in country II. Now let us assume – defining ß' and ß" as positive parameters and w=:W/p – for simplicity that we have f_L=ß'f(…)/L, f^*_L=ß'*f*(…)/L. We thus get an explicit solution for profit-maximizing employment in the headquarter country:

(III) L^{opt}= {[Aß'f(…)]+ [A*ß'*f*(…)]}/(W/p)

As regards employment abroad, we have the following solution:

(IV) L^{*opt} = ß'*f*(…)A*/[eW*/p] = ß'*f*(…)A*/[αw]

As regards employment abroad, the solution is straightforward and simply says that the real wage rate should be equal to the marginal product of labour abroad and that employment abroad will fall if the relative wage ratio α is rising. The more interesting employment aspect concerns domestic (human capital) employment which is basically linked to the product wage rate w and the marginal domestic product of labor and the international productivity spillover effect; note also that a rise of A* raises domestic employment. If the law of one price is not holding there also will be a market share effect. In the theoretical approach presented home employment is a negative function of the product wage rate w; and it is a positive function of labour production in country I and of the international labour productivity spillover effect. As long as the firm is a price taker in the labour markets, the implication is simply that employment in the home country benefits from both the international productivity spillover effect. Therefore there could be a positive sum effect in international offshoring. In the context of the ICT sector, one may indeed assume that for complex products the asymmetric international productivity spillover effect is strong. The larger the international spillover effect – disregarding A and A* for the moment – the higher the employment in country I. If A* can be raised at zero marginal costs, employment both abroad and at home could increase. As soon as the global increase of output brings about a fall of p, however, the net employment effect in country I could become negative; in our model this aspect can be accommodated by writing p=p(A, L, A*, L*), which amounts to saying that the price is a negative function of output. It is also obvious that a high speed of international technology transfer in the sense of A* approaching sufficiently quickly the exogenous A implies a fall of employment in country I since profit maximization suggests replacing domestic employment by additional employment abroad.

If the firm is in a sector which represents key bargaining behaviour, collective bargaining could lead for our standard set-up to a rise in the real wage rate beyond domestic marginal labour productivity. In this case offshoring would not bring additional employment in the home country, but rather a rise in the real wage rate. Hence, if trade unions are strong enough to bid up wages in the home country/FDI source country in a way that international productivity spillovers are fully internalized, offshoring will not result in direct employment effects in the home country; there could, however, be indirect employment effects in other sectors of country I since the real wage under certain conditions will translate into a rise in the sectoral real wage bill.

In reality one may have to consider fixed setup costs Z'* of establishing a subsidiary production abroad. In addition one may note as a more realistic setting that offshoring requires a certain minimum output abroad if there are costs of laying-off workers in country I (associated with FDI) – this perspective nicely gives an intellectual bridge to insider-outsider model of the labour market (by assumption outsiders both abroad and at home cause no lay-off costs, but there will be hiring costs; and those could be higher in country I than in country II). Finally, we can make an assumption about international technology transfer. In the case of foreign direct investment a full transfer as the simplest case implies $A=A^*$, but this indeed is not realistic if there is a considerable general technology gap between both countries. One might consider instead for country II firm-level specific or sectoral learning-by-doing effects which could be modelled as positively depending on relative cumulated production$[\sum F^*/\sum F)]$ – with the time index running from $-T$ to $t=0$ – and the exogenous level of A, respectively, so that we have (with $0<\beta''^*<1$ which is required to obtain a steady state solution for A^*) the following differential equation for catching up: $dA^*/dt= A[\sum F^*/\sum F]\ A^{*\beta''^*} - \beta'''^* A^*$. The term $[\sum F^*/\sum F)]$ is a special form of dynamic scale economies; the parameter β'''^* indicates the speed at which knowledge in country II is depreciating, the parameter β''^* basically indicates the speed of "gross learning". For the specific case that we have in international equilibrium $\sum F^*= \alpha' \sum F$, the steady state solution $A^*\#$ is given by:

(V) $A^*\# = [\alpha' A/\beta'''^*]^{1/1-\beta''^*}$

Only specific parameter conditions for β''^* and β'''^* imply that in the steady state solution $A^*=A$ which means full technological catching-up; clearly, ICT will affect the parameters considered and can be expected to raise the speed of catching-up within the respective multinational firm. Moreover, the relative per capita income y^*/y could also positively affect the sectoral/firm-specific catching-up process. Note finally that international income convergence is not generally to be expected in such a setup of asymmetrical international productivety spillovers. As regards empirical evidence on productivity spillovers related to the presence of foreign investors there is evidence for Ireland and Spain (Barrios et al. 2004); in the case of Ireland the ICT sector plays a particularly strong role with respect to FDI inflows and "foreign employment", respectively.

An Integrated Theoretical Approach: Trade, FDI and Intermediate Products

Theoretical analysis has presented models for a simultaneous analysis of trade and foreign direct investment (e.g. Markusen/Venables, 1998, Hummels et al. 1998); advanced models also have been developed by Brainard (1993) and Kleinert (2002). The latter follows the former in presenting an approach which relies on a perfectly competitive sector I (producing a homogenous good) and an imperfectly competitive manufacturing sector with final goods producers and intermediate goods producers; both types of industrial producers offer differentiated goods in the context of monopolistic competition. Final goods producers are characterized by multi-stage production which includes fixed inputs (e.g. R&D) at the corporate level and at the plant level (capital equipment). Firms choose between exports and production abroad so that foreign markets can be served through alternative strategies. Exports save on additional fixed costs at the plant level, whereas production abroad saves on distance costs. The Kleinert model – emphasizing among other elements the role of intermediate products (see also Feenstra, 1998; Campa/Goldberg, 1997; on empirical aspects Meti, 2001; Head/Ries, 2001) assumes that intermediate goods are specific either to the final good or to the production process so that final goods procuers use intermediate goods exclusively from their home country, even if they produce abroad: That is, there is potential multinational production of final goods while intermediate products are traded; final goods also can be traded; and this theoretical approach to intermediate input production changes results obtained in the context of models with distance costs and endogenous emergence of multinational enterprises (MNE; see Brainard, 1993; Markusen/Venables, 1998). In approaches without intermediate goods a decline of distance costs reduces the profitability of foreign production relative to exports. The Kleinert model is different since intermediate goods used in the foreign affiliate incur distance costs too. As Kleinert (2002, p.5) notes: "For high distance costs, exports and foreign production are low. Profits of the foreign affiliate would not be high enough to cover the additional fixed costs at the plant level. The company serves the foreign market through exports, because exports do not require fixed costs and are therefore also profitable with low sales. But a small reduction in distance costs increases profits of production abroad more than profits of exports. For intermediate distance costs levels, profits of foreign affiliates might be or might not be sufficient to cover the additional fixed costs at the plant level. Hence, MNEs may arise depending on industry characteristics (fixed costs levels, degree of product differentiation, share of intermediate goods in production). For small distance cost levels, savings of distance costs are not large enough to make up for the additional fixed costs at the plant plant level. Companies always prefer export to production abroad". A higher degree of product differentiation reinforces the role of MNEs. Moreover, the number of firms in the case that in equilibrium there are only national companies is higher than in a MNE equilibrium. A higher share of intermediate goods – if this share is not below a critical ratio - will decrease the relative profitability of foreign direct investment (in final goods production). Increasing fixed costs at the plant level will broaden the range of profitable FDI.

From the perspective of the Kleinert model we may argue that the ability of ICT to create a larger variety of products should reinforce the role of foreign direct investment. Moreover, if ICT goes along with higher R&D expenditures (or other fixed costs at the plant level) the role of foreign investment also will increase. As ICT is facilitating the production of intermediate goods – the value-added chain can be easier sliced – we have a third argument in favour of higher foreign direct investment. Thus ICT should contribute to more foreign direct investment; in the context of EU eastern enlargement this implies that EU accession countries potentially stand to benefit more strongly from foreign direct investment inflows than in a world without ICT. However, in the context of economic globalization this implies that there is a rising risk that the EU25 will face Community FDI outflows; but at the same time the Community – assuming that it offers crucial locational advantages important for multinational ICT companies from the USA and Japan/Asia – stand to benefit from rising FDI outflows from the USA and Japan/Asia. Finally, let us note a cricital caveat with respect to the Kleinert model and the ICT-related conclusions, respectively, namely the fact that intermediate goods production can also take place abroad.

If we assume that only intermediate output is characterized by FDI – and not final goods production – two final goods producers from two high wage countries will consider international offshoring options under the aspect whether offshoring reduces costs one the one hand and affects the marginal value product of the final goods producer: If offshoring allows the headquarter country – highly endowed with human capital – to specialize more in R&D-intensive activities the multinational company will be able to combine lower overall production costs with higher prices in world markets where the firm will sell more innovative and more expensive products. In the presence of static or dynamics scale economies prices will fall over time, but the basic mechanism identified here will not change unless the growth-enhancing effects of scale economies go along with a strong relative increase in the demand for differentiated goods characterized by absence of scale economies. ICT expansion implies more opportunities for product differentiation on the one hand, on the other hand it might facilitate easier exploitation of scale economies as ICT reduces transportation and information costs and thus creates larger markets.

2 Interdependencies Between ICT, Growth and Internationalisation

2.1 ICT and Growth

Since the 1990s, ICT has been a major driver of economic growth in OECD countries. There is a broad consensus in the literature that ICT production (mainly due to high rates of process innovations) is contributing to growth. Moreover, there is also some evidence that the use of ICT contributes to output growth (VAN Ark, 2001; Welfens, 2002; Audretsch/Welfens, 2002 Barfield /Heiduk/Welfens, 2003). There is considerable evidence that ICT plays an important role on the growth differential between the US and EU15: Jorgenson/Stiroh (2000), Colecchia/Schreyer (2002), Oliner/ Sichel (2002), Stiroh (2001), Jorgenson (2003) and Inklaar et al. (2003) have argued that ICT production and the use of ICT (that is cumulated ICT investment) are important drivers of productivity growth. Gordon (2004) is more cautious about the link between ICT and growth. As regards Eastern Europe, Van Ark/Piatkowski (2004) find some evidence that ICT significantly affects productivity and output growth. Welfens/Ponder (2003) and Ponder/Markova (2005) have shown that Eastern European countries have considerably caught up in the field of telecommunications, however Russia lags behind EU accession countries.

Comparing the periods 1995-2000 to 1979-1995, the Inklaar et. al. analysis of labour productivity growth in the US and EU-4 finds a rise of 1.25 percentage points in the US and a reduction of 0.27 points in the EU. The growth accounting estimates show that labour quality changes have declined in both the US and the EU-4 labour productivity. The employment reallocation effect in the US was good for + 0.05 points, but in the EU-4 the figure was -0.06 points. ICT producing industries generated similar impacts on productivity growth in the US and the EU, namely 0.04 and 0.03 percentage points respectively. As regards the impact of ICT-using industries, the EU did not reach even half the increase of the US which was 0.29 points, the main effect stemming from financial services (0.17 in the US; 0.02 in EU-4). Non-ICT capital deepening contributed to 0.08 points in the US and -.45 points in the EU. Total factor productivity contributed 0.79 points in the US, but only 0.13 points in the EU-4. The impact from ICT-producing industries was rather similar on both sides of the Atlantic (0.36 in the US vs. 0.24 in the EU), but in ICT-using industries there were much bigger differences; in particular wholesale trade, retail trade and financial services seem to be problem areas for Western Europe. Weak EU15 productivity increases and slow growth are all the more unsatisfactory since Germany, France, Italy and Spain suffer from high unemployment rates and since slow growth in 2000-05 seems to indicate that the ambitious goals of the EU Lisbon Agenda (aiming at higher growth and employment by 2010) will not be achieved. However, there is a range of reports from the European Commission which analyze the dynamics of the information society developments and suggest policy options for stimulating digital modernization in EU accession countries (Bogdanowicz/Centeno/Burgelman, 2004; Bogdnowicz/Burgelman/Centeno/Gourova/Carat,2003; Gourova/Burgelman/Bogdanowicz/Herrmann, 2002).

A growth accounting analysis by Sakellaris/Vijselaar (2005) for the Euro zone has tried to take into account the role of quality changes in capital formation and in output. (Unfortunately this SOLOW-type growth accounting exercise does not take into account labour quality aspects. Moreover, the analysis might suffer from methodological problems since the focus is on the Euro zone with its high unemployment figures which rather suggests relying on data envelopment analysis.) This leads to an upward correction of output growth figures for 1982-1990 and for 1991-2000 by about 0.5 percentage points in both periods. The role of capital growth, based on quality adjusted figures, increased by 0.33 in the first period and by 0.45 points in the second period; among the sub-categories IT hardware, software, communication equipment, other machinery and equipment, transport equipment and non residential construction, the combined contribution of IT hardware, software and communication equipment amounted to 0.26 percentage points in the first period and 0.2 percentage points in the second period (reflecting a modest upward revision from quality-unadjusted figures; as regards software quality, adjustment brought no change in the assessment). Total factor productivity growth accounted for 2.2 points in the first period and 1.46 in the second period which had shown a deceleration of growth (2.34 % growth of GDP compared to 2.97% in the first period; both quality-adjusted figures are 0.6 percentage points higher than the figures without quality adjustment). The growth of total factor productivity growth is decomposed in equipment and software plus “rest”; equipment contributed 0.59 percentage points in the first period and 0.63 percentage points in the second period.

In the 1990s, the overall contribution to growth in leading OECD countries was – according to OECD figures – between 0.5 and 0.8 percentage points, which is rather impressive for a sector which hardly accounted for 10% of aggregate output at the beginning of the 21st century (and for 15-35% of investment). ICT is a broad field which contains computers & software, telecommunications and modern digital services, all of which are inputs in all sectors of the economy. ICT is also crucial for innovation, since a rising share of R&D expenditures is accounted for by the ICT sector. Nevertheless one cannot argue that ICT expansion has stimulated growth in a rather homogeneous way across OECD countries, and indeed only a few OECD countries have experienced a considerable increase in labour productivity or technological progress in the context of the growth of ICT. Pilat (2005) argues that very few countries have witnessed an upsurge in labour or multi-factor productivity growth in those sectors that have invested most in ICT. Among the factors explaining this – according to Pilat – are differences in the countries' respective uptake of ICT (OECD, 2003; 2004b): ICT investment rose from less than 15% of total non-residential investment in the early 1980s to a range of 15-30% at the beginning of the 21st century; the share of ICT investment was relatively high in the US, the UK, Sweden, the Netherlands, Canada and Australia (OECD, 2004b), where the update of ICT is partly linked to differences in the direct costs of ICT (ICT equipment, telecommunications, installations of e-commerce systems etc.). These costs still vary across OECD countries, despite rising ICT trade and the liberalization of telecommunications. Moreover, countries differ in the degree of competition in ICT markets and in the respective ability to absorb ICT and use this technology effectively, which in turn is related to the availability of know-how and skilled labour. There also could be a lock of complementary process innovations in Europe which explains the relatively modest productivity gains in some continental EU countries, and a lack of new firm creation in ICT-using services could play a role.

This suggests that ICT dynamics are significant in four respects for the Euro zone and for other EU countries:

- quality adjustment of output;
- contribution to capital growth;
- increase in total factor productivity growth;
- rise in per capita income.

To the extent that ICT expansion contributes to growth, there should be improved opportunities for start-up companies. A considerable share of such start-up companies will be in the ICT sector itself; but as an intensive use of ICT plays a particular role in almost all high-technology sectors, there is a natural interest in high-technology start ups, including ICT start-ups (e.g., software, ICT goods).

Innovative Niche Sectors, Growth and Internationalisation

As higher per capita income goes along with a rising demand for differentiated products – product differentiation often requires intensive use of ICT – and since income elasticity for ICT goods exceeds unity, the demand for ICT goods will increase, thereby creating a virtuous ICT expansion circle. In parallel, there is further accumulation of knowledge capital and ICT capital, and the relatively increasing use of ICT facilitates fragmentation in the ICT producing sector and the digital services sector. While the ICT digital services sector is strongly shaped by large companies, one should not overlook that a considerable share of activities is conducted by young high-technology start-up companies. Much of the advanced digital services indeed take place in an environment of relatively young firms. From a theoretical perspective, internationalisation of business in technology-intensive (and knowledge-intensive) sectors is related to:

- successful expansion in the domestic market: Internationalisation, measured by relative sales abroad, allows technology oriented/knowledge-intensive firms to more easily recover R&D expenditures;
- the ability to sell standardized services or goods in national and international markets. However, standardization takes time in knowledge-intensive sectors and young high-technology start-ups offering highly customized products and services – with a narrow focus on customers – are less likely to quickly expand internationally.

Given the fact that ICT is a relatively young sector, one may anticipate that a considerable share of high-technology start-ups – with a focus on complex software development projects or certain advanced ICT products – are mainly operating in niche markets of the home country. Indeed that part of ICT which is high-technology intensive deserves special attention. It is particularly interesting to analyze the internationalisation performance of high-technology start-ups and to contrast internationalisation of ICT high-technology start-ups and young non-ICT high technology firms. A comparative survey study on German and British high-technology start-ups (Burgel/Murray/Fier/Licht, 2000) has shown that internalisation activities are all the more likely to occur if the company

- is older
- is larger (measured in terms of employment at start-up)
- conducts regular R&D projects and innovation activities
- has founders with international managerial experience

Moreover, the internationalisation of "new technology-based firms" is less likely to be observed if the company:

- sells products highly customized to the need of the demand side of a small number of customers
- sells software services as opposed to manufacturing products.

The study shows that both small firms and large firms can internationalize. When moving from casual to more long term committed internationalisation – measured by the number of foreign markets entered –, however, the impact of the above mentioned variables become even more important. The sector involved also matters; in the engineering and life science sector, the importance of international sales is more important than in software activity. Given the fact that both the UK and Germany are countries considered to be leading EU software development locations, one may infer from this that a considerable share of software – a crucial subsector of ICT – is internationalizing only at a modest pace. This seems to partly be due to the fact that software start-up companies are successfully operating in national niche markets. Moreover, one should not forget that the software sector is relatively young compared to engineering and other manufacturing core sectors. By implication, one may anticipate a long term internationalisation process in key activities of the ICT sector. The mode of internationalisation chosen often had a focus on foreign direct sales and the use of a distributor which accounted for roughly 70% of all sales choices in the overall sample of high-technology start-ups. As Burgel/Murray/Fier/Licht (2000, p. V) maintain, "Products which require a significant level of installation costs or are highly customised were invariably sold directly and not via agents or distributors. If the founder managers had international experience or if the firm had a high R&D intensity, this also increased the tendency of the firm to export directly. Conversely, increased technological innovation in the products and the previous commitment to international sales in a business plan each increased the likelihood that a distributor would be employed in foreign markets. Firms from industries which traditionally employ distributors, such as ICT hardware and pharmaceuticals, are also more likely to continue to adopt this accepted market channel…More innovative products tend to be sold via distributors. This was explained through the introduction of the concept of "the liability of alieness". By this term we mean that a demanding corporate user may not be prepared to accept the product or service of an unknown and untested company unless supply is mediated trough a familiar and trusted intermediary."

- One should emphasize that this theoretical approach convincingly explains that exporting and using a local distributor is a preferred mode of internationalisation for young high-technology ICT firms. One should, however, expect that with increasing age and reputation, high-technology ICT will be able to rely more on direct sales to foreign customers, which should translate into higher profit rates in the export market, thus allowing the respective ICT firm to accumulate rising capital as a required basis for foreign direct investment in lager stages of expansion. As regards ICT high-technology firms – representing merely a part of the overall ICT sector – we thus have the following sequence along the ageing of the firm:
- start-up stage: internationalisation takes place mainly through the use of foreign distributors which replace the lack of reputation of the high-technology ICT start-up
- early expansion stage: internationalisation increasingly relies on direct sales to foreign customers
- advanced expansion stage: foreign direct investment – bringing with it the advantage of being close to key customers abroad – plays an increasing role.

In young fields of high-technology ICT activities, the EU should thus anticipate that foreign investors form third countries (e.g., the US, Canada, Japan) will play a role only in the long run. By the same token successful high technology-start ups in the EU ICT sector can be expected to switch from exporting to a more foreign investment based strategy only in the long run. The implication here is that transatlantic ICT trade will be partly replaced by two-way ICT foreign direct investment in the medium and long term.

Economies of Scale Intensive ICT Goods and Internationalisation

From a standard theoretical perspective, it is clear that sectors producing scale-intensive goods face natural pressure for internationalisation. As exporting allows for production on a larger scale, there are straightforward cost advantages from internalisation through exporting.

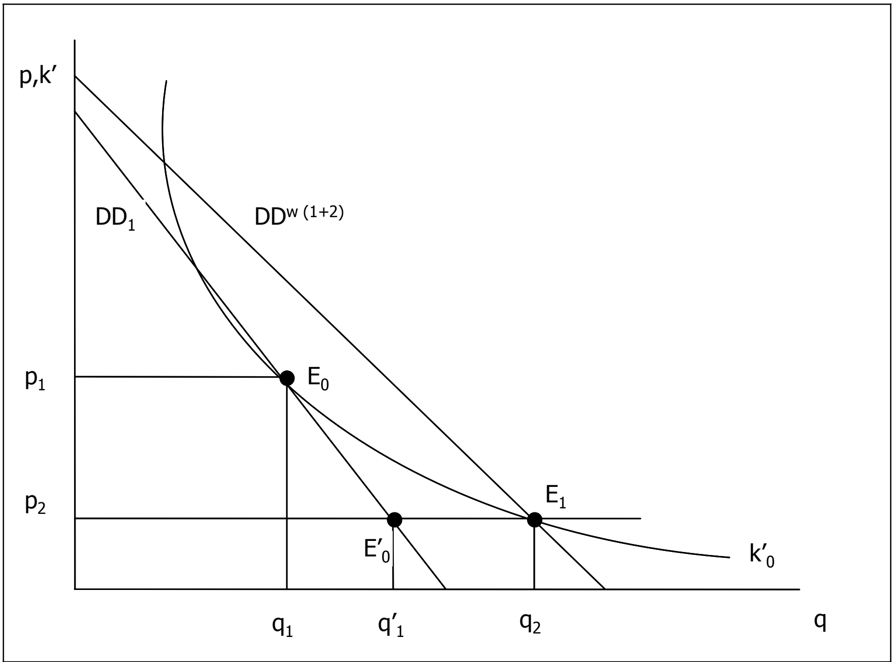


Fig. 6. Scale-intensive Production and Trade

If domestic demand is given by DD_1 in Fig. 6 and the world demand is $DD^{W(1+2)}$, there will be exports equivalent to q_2-q'_1; exporting allows the domestic economy to also benefit as the price falls to p_2 – which is much lower than p_1 – in a closed economy where production would be only q_1. A specific aspect of ICT production is that there are both static economies of scale – with marginal costs being a negative function of the current output volume – and dynamic economies of scale (meaning that marginal costs are a negative function of cumulated past production). In such an environment, price setting strategies are complex as costs must be recovered during a dynamic product cycle in the presence of scale economies. In such a setting, a large domestic home market is a useful shelter.

The specific element of the ICT sector is that the ICT-producing sector represents weightless goods, so that transportation costs play a relatively small role when it comes to international outsourcing or offshoring in a multi-country model. The final goods producer has an incentive to outsouce the production of intermediate goods to that low wage country whose technological capability is sufficient to deliver the desired quality. If outsourcing of a component has initially favored country i, economic and technological catching up of country j – assumed to initially have been backwards relative to i in technological terms – will lead to second-stage outsourcing in the sense that producers in j could outsource certain standardized components of their value-added to country j; whether full outsourcing from i can be avoided will largely depend on the ability of producers in country i to upgrade the quality and sophistication of the intermediate product. In this case, a full substitution from i to j would not take place.

International outsourcing often concerns rather simple intermediate products which are produced in newly industrialized countries or developing countries. The well-known fact that the knowledge-intensive chip design is often made in California (or in Scotland, Southern Germany, Southern France etc.) does not rule out that chip production is made in Asian NICs which have relatively low labor costs. While the final product – the chip – is a high-technology product, the scale-intensive production process of the chip itself is rather standardized once that the initial innovation state has passed, thus making standardization of production increasingly important over time. Foreign direct investment is likely to be a preferred option for ICT internationalisation in the case of ICT goods, which are both knowledge-intensive (and technology-intensive) and scale-intensive. The mass production of most chips is such an example. The production of chips is R&D-intensive and is certainly characterized by a high rate of technological progress over time. Indeed, neither the high progress rate in the ICT-producing sector nor the fact that many activities in the ICT-producing sectors contribute to economic growth is subject to scientific controversy.

2.2 Growth, Competitiveness and Outsourcing Dynamics

Achieving sustained economic growth is a key challenge for industrialized countries which rely on the accumulation of capital, human capital formation, technological progress and positive spillovers to generate growth. Analytically, spillovers have played a prominent role in endogenous growth models, which rely on constant returns to a sufficiently broad concept of capital accumulated over time (Romer, 1986; 1987; Lucas, 1988; Rebelo, 1991). A complementary approach to endogenous growth can be found in the R&D based models of Romer (1990) and Grossman/Helpman (1991a, 1991b), who emphasize accumulation and product upgrading. The emphasis in Aghion/Howitt (1997a, 1997b) is on combining R&D and capital accumulation. Marrewijk (1999) presents an interesting and important extension, integrating the expansion of product variety rather than quality improvements (vertical differentiation as opposed to horizontal differentiation). Secondly, he looks at knowledge spillovers and learning. Finally, he considers different production technologies in the R&D sector and in the final goods sector, departing from the standard assumption of identical technologies in these two sectors (Rivera-Batiz/Romer, 1991; Barro/Sala-I-Martin (1995), Aghion/Howitt (1997a, 1997b).

Rising trade (in intermediate products) will lead to different results if we consider neoclassical trade theory and modern trade theory (typically with a simple focus on two countries):

- Traditional neoclassical trade theory suggests that more trade should contribute to international price equalization and hence to factor price equalization, which in turn reinforces economic convergence. Fragmentation could to some extent indeed be considered a new element relevant for factor price equalization.
- Modern trade theory offers models with skilled and unskilled labour (Feenstra, 2004), whereby introducing trade with intermediate products leads to a relative increase in the demand of skilled labour in both countries. If wages are not fully flexible in both countries, a key result will be unemployment in one of the countries or in both. If one country has full employment and the other structural unemployment of unskilled workers, it is clear that factor price convergence and hence convergence of real per capita income will slow down.

From a macroeconomic perspective, trade in intermediate products (so-called intra-product specialization (Arndt, 1996) can have considerable effects: Deardorff (1998) has shown the following results:

- If fragmentation does not change world market prices of goods, it will increase the value of output of any country in which it occurs as well as that of the global economy.
- If fragmentation affects prices, it can lower the welfare of a country by turning its terms of trade against it.
- Even in a country that profits from fragmentation, the welfare of some factory owners within that country might decrease.
- If factor prices are not already internationally equalized in the absence of fragmentation, the process of fragmentation may be an impulse toward factor price equalization.

A high share of modern ICT manufacturing goods typically falls into the category of:

- science-based high quality products which represent high R&D intensity and often high human capital intensity as well;
- differentiated products which are complex customer-tailored goods consisting of many components

Modern ICT services are characterized by:

- high complexity of the underlying software where the digital product itself can easily become a me-too product once the respective software price has fallen so much that the software becomes broadly available to the public;
- high quality uncertainty which makes the respective digital service become a kind of "confidence good", whose quality is difficult to assess and for which market failure is looming. Providers try to overcome this problem by emphasizing long term contracts and reputation building which partly points to the role of the size of the home market (with firms from small countries being disadvantaged as they are hardly able to acquire much larger firms in large countries). This, for example, concerns manager liability insurance which can be offered and sold through the internet, but insurance firms from the relatively advanced

Netherlands (with a high coverage of the relevant market) find it quite difficult to conquer the neighboring German market. There firms face competition mainly from US companies which, regarding the issue of whether firms would pay in a critical case, are not trusted very much by potential clients.

Whether we consider ICT products or ICT services, it is clear that in the modern networked global economy there are many profitable outsourcing opportunities which every final product firm will have to take into account in the long run. Once the firm has exploited domestic outsourcing opportunities, it will consider international outsourcing or offshoring; the international options will play a strong role if the respective activities to be relocated across countries involve components for which the respective inputs show strong international factor price differentials.

Outsourcing means that a final product firm reduces the share of value-added below 100% and orders intermediate products from other firms at home or abroad. One may assume that in a model with heterogeneous products each product can technically be split into sub-products of declining complexity in terms of technology and value-added. The smaller the value-added, the lower the complexity of the component. At the same time we assume that countries in the world economy differ in terms of relative wages, with the highest wage rate being paid in the country with the highest per capita income as well as the highest technology level. One may assume that the producers of the most expensive and complex final goods are located in the most advanced country with the highest per capita income level. (In the real world with small and large countries, the size of the economy could also have an impact, which we will ignore for the moment.)

Endogenous Growth Perspective

From a theoretical perspective, one may emphasize the endogenous growth model of Zon/Muysken (2005), who have highlighted in a refined Lucas-model the role of ICT in a modern growth model, according to which ICT capital intensity has a positive impact on the knowledge accumulation process; ICT is important both in final goods production and in knowledge accumulation. The expansion of knowledge and the rise of ICT capital intensity contribute to higher steady state growth of output. Knowledge accumulation thus plays an important role for economic growth. The implication is that the long run increase of ICT capital intensity in OECD countries and NICs – fuelled by falling relative prices of ICT capital goods – will reinforce the role of knowledge in production. As regards long term dynamics, however, one should not overlook the problems of information markets themselves which suffer from market imperfections.

Hempell (2006) has emphasized that ICT is not a panacea for productivity gains, rather ICT raises productivity mainly by acting as a catalyst for innovation and the upgrading of skills; basically he suggests several conclusions based on a large sample of German firms and findings for the Netherlands (Hempell et al. 2004):

- ICT use stimulates productivity: a 10% increase in the firm's ICT capital stock raises company productivity by roughly 0.6%. Given relative factor endowments in the sample of firms considered, annual returns on ICT investment are likely to exceed its user costs for many years to come.

- A crucial element of ICT productivity reflects improved quality of output. Quality improvements are quite important.
- Productive ICT use is complemented by innovation dynamics and innovative activities. Successful use of computers and the internet requires companies to introduce their own innovations.
- Innovation history is important; service firms that have introduced innovations in the past are found to be better in using ICT productively than firms that have not, and the empirical results point to a major role for process innovation as a basic source of experience in ICT use.
- ICT productivity is contingent on the skills of workers and employees. The higher the share of highly-skilled workers in firms, the greater the productivity contribution of ICT.
- Hempell (2006, p. 180/181) summarizes his key findings in crucial "aspects of how firms make computers and the Internet contribute to productivity. First, ICT use does not substitute for but serves as a complement to firms' own innovation activities…Even though these findings are obtained mainly from firm-level analyses for Germany...and similar findings for the Netherlands…the relevance of innovative experience may also be useful for understanding varying productivity effects of ICT in different countries. The more competitive business environment in the U.S. may be one reason that helps explain why the productivity impact of ICT has been much higher there than in continental Europe. The higher innovation pressure in the U.S. over the last decades may have led firms to collect more diverse innovative experience than more protected firms in Europe. By increasing the returns to skills and innovation, the diffusion and continuous improvement of ICT fosters investments in skills and innovation also in numerous sectors outside the ICT-producing industry. Due to these secondary effects as a catalyst of innovation and upgrading of skills, computers and the Internet do not only contribute to productivity as an increasingly cheaper and more powerful factor of production, but may induce knowledge spillovers that accelerate the growth rate of the aggregate economy."
- For the medium term, Hempell (2006, p. 182) sees two partially opposed ICT developments. ICT access will become simplified and ubiquitous, with innovation opportunities becoming more complex and expensive from ICT use.
- On the one hand, falling computer prices and increasingly standardized software will make ICT more ubiquitous and easy so that ICT could become less important for sustained competitive advantage of firms. This implies that ICT will diffuse in the world economy.
- Technological progress in ICT hardware and software present new options for a growing range of ever more complex innovations, including novel types of knowledge management. This includes new ICT-based tools and broadband internet access which will facilitate the collaboration of R&D teams scattered around the world (Fraunhofer-Gesellschaft, 2004). The implication of this is that the internationalisation of ICT as a high-technology field will be concen-

trated in advanced countries which are endowed with highly skilled labour and which have made investments in modern broadband e-communications networks. North America, Europe, Japan and a few Asian countries fall into this category.

At the bottom line, the theoretical analysis suggests that ICT expansion will stimulate economic growth, and this all the more the higher public and private investment in complementary human capital formation is. There is a positive interdependency between growth and internationalisation of ICT:

- Higher growth implies higher per capita income and this in turn will go along with a rising demand for differentiated products; producing more varieties often goes along with an increasing use of ICT capital.
- Higher growth implies better opportunities to exploit static and dynamic scale economies. Those ICT activities and sectors which are strongly characterized by scale economies thus stand to gain particularly.
- As trade growth is faster than output in OECD countries and Asian Newly Industrializing Countries and since international outsourcing in the field of ICT goods is faster than the average observed in manufacturing industries, one may anticipate that normal ICT sectors – not those representing a very simple product with only one stage of production (going along with low knowledge intensity) and not those signifying very complex products (requiring high knowledge intensity) – should be shaped by more than average internationalisation dynamics.

Economies of Scale and Knowledge Intensity

Exploiting economies of scale and high knowledge intensity are relatively easy to combine for large firms operating in large – and technologically advanced – countries. One should, however, not rule out that small firms from a small country can be successful in a market which is characterized by economies of scale and high knowledge intensity; the most inter-esting case is Taiwan where government's development policy has nurtured cooperative R&D and joint technology diffusion through specific programmes which effectively invited firms from the electronics sector to create a kind of technology club for which a modest entry fee of $ 48 000 was required; 46 firms joined this club (Ernst, 2000). Some firms graduated in terms of technology and knowledge intensity over time and become original equipment manufacturers (OEM) for global companies: Firms eager to foster the respective global brand name while exploiting international costs advantages outsourced a high share of intermediate input to firms in Taiwan; and this went along with considerable international knowledge transfer and knowledge accumulation, respectively. A firm which aims at global leadership and commercial presence, respectively, indeed faces considerable pressure to outsource intermediate production and thus to contribute to international knowledge diffusion. This process has allowed the respective Taiwanese firms – including local suppliers of tier I suppliers for the global MNC – to accumulate specialized knowl-edge and also to upgrade in terms of management, quality and product sophistication; moreover, foreign direct investment inflows have considerably contributed to international knowledge transfer. The focus of Taiwanese suppliers (in an early stage of internationali-zation) on global MNCs and global markets, respectively, allowed to also exploiting economies of scale in the production of intermediate goods. The computer firm ACER hired an IBM manager to finally become a global company and indeed wanted to act as a brand setting firm which amounted to full competition with IBM. However, the first attempt with its strong focus on OECD countries failed, but the second attempt – with a strong focus on the world economy's peripheral markets where competition is not so stiff – allowed ACER to combine internal knowledge and scale economies in an efficient way and to finally become a global company. These developments hold valuable lessons for companies in both EU accession countries and in EU15; there are also clear implications for policymakers.

2.3 A Closer Look on Digital Goods and IT Services

2.3.1 Characteristics

With the development of the Internet as a worldwide network, the importance of IT Services and Digital Goods have risen. Their diffusion has been pushed forward by growing broadband networks. According to Quah (2002) digital goods are

- nonrival,
- infinitely expansible,
- discrete,
- aspatial[1], and
- recombinant.

This implies that the marginal costs of reproducing digital goods are almost zero, showing high economies of scale. They are costly to produce but cheap to reproduce. They can be reproduced arbitrarily often without lost of quality. When the price exceeds marginal costs the benefits of price discrimination become very apparent (Varian (2004)). Versions and adoptions can be produced easily, implying new pricing and marketing models. Also the transport costs of digital goods are very low compared with the transport costs of manufacturing goods. They are non-perishable and easy to store; therefore production and consumption can be separated in location and time. Finally a quick and comprehensive analysis of customer behaviour (Mahnke/Venzin (2002)) is possible.

Regarding IT Services, EITO (2005) differentiates between consulting, implementation (installing, testing, training, etc.), operations management and support services. Considering the functions of information systems in the production process, Dibbern/Heinzl (2002) introduce the following classification:

- System Operations/ Data Centre (e.g., installation, operation and technical maintenance of client/server systems or systems software)

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1 aspatial: at once everywhere and nowhere

- Telecommunication / Networks
- Development and Implementation of Applications (e.g., development of software, system analysis, project management, data administration)
- Help Desk (e.g., advise, support, training, instruction and problem management)
- Planning and Management (e.g., integration of business planning and information systems planning, identification of future innovations, conception of system architecture, standards and methods).

Another classification regarding functions in companies is given by Allweyer et al. (2004). They differentiate between processes (organizational aspects), applications (e.g., software) and infrastructure (e.g., hardware, networks, operating systems). Sometimes a classification orientated toward technical characteristics may also be useful: From a technical point of view, different layers work in an IT system (and in a personal computer). These are the network layer, hardware layer, system software (operating system) layer, the middleware layer and finally the application software layer.

An Example of IT services is hosting a website. This means supplying a server (hardware) with a webserver (program) which sends .html (and other) codes when requested. Customized software should also be considered an IT service (see next section).

2.3.2 Software on the Borderline Between Goods and Services

The link between IT services and digital goods is strong; the (automatic) translation of a text via a WebService is an IT service whereas the stored result (e.g., an e-book) might be a digital good. Contrary to digital goods, IT Services cannot be stored. Contrary to digital goods, the utility of an IT Service is often bounded to a special time or a special customer.[2] Economically speaking, it is easier to exploit scale effects by producing digital goods than by offering IT Services. Furthermore a digital good may be designed for a household (B2C-product or final product), whereas IT services are intermediate products (B2B-products) by definition.

Despite this definition, some products such as software can be classified as a service as well as a good. The value added by burning the code of an individually developed commercial software system onto a CD is negligible compared to the

[2] According to the 1993 System of National Accounts (SNA) services are defined as 'not separate entities over which ownership rights can be established. They cannot be traded separately from their production. Services are heterogeneous outputs produced ... By the time their production is completed they must have been provided to the consumers'. The SNA 1993 also claims that the outputs of the Service industries "are often stored on physical objects—paper, tapes, disks, etc.—that can be traded like ordinary goods. Whether characterized as goods or services, these products possess the essential characteristic that they can be produced by one unit and supplied to another, thus making possible division of labour and the emergence of markets" (UN (2002)).

development costs of the software. From the economic point of view, the prevailing characteristic of the product must taken into consideration.

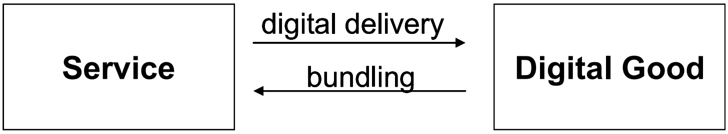


Fig. 7. Closer Relationship between Services and Digital Goods

The links between services and digital goods are getting closer (Fig. 7). Vickery/Wunsch-Vincent (2005) point out that the digital delivery of business services is growing, but the suitability "is mainly affected by the centrality of information exchange, level of standardisation, complexity of task, nature of the problem and the knowledge involved, and the context of delivery." On the other hand digital goods (especially software) are increasingly bundled with additional service components such as automatic updates, consulting and the like; this bundling strategy can be seen as a form of versioning.

The classification of software as good or service is also an unsolved issue with respect to the adaptability of WTOs trade regimes GATT (for goods) and GATS (for services). According to Wunsch-Vincent (2005), most WTO members agree that the majority of electronically traded services should be governed by GATS, but they do not agree on the classification of digital products delivered on a physical medium like CD or DVD.

Statisticians solve the classification problem by introducing extensive rules of definitions. According to the Extended Balance of Payments Services (EBOPS) classification, hardware and software consultancy and implementation services, maintenance and repair, ..., design and programming of systems ready to use (including web page development and design), ..., development, production, supply and documentation of customized software, including operating systems made on order for specific users, ..., web page hosting services and computer facilities management' are regarded as computer services. But on the other hand all 'packaged (non-customised) software' are classified as goods (UN (2002)).

Following this double-sided characteristic, software is mentioned as a digital good and an IT Service in this paper emphasizing the high level of standardization of B2C and Standard-Operating Systems Software on the one hand and the high degree of individuality of many B2B-Software-Tools on the other.

2.3.3 Trust and Branding in the Digital Economy

When replacing personal contact with contact over IP connections, trust becomes a key element of the digital economy. A famous tool for delivering digital trust is eBay's reputation service, with which buyers and sellers can evaluate their performance after a deal. The rank works as an indication of trustworthiness and influences the margin of buyers and sellers. Most of the evaluations given are 'positive', positively influencing thereby the reputation of the eBay-platform (Resnick/Zeckhauser (2002)).

Trust in general is a function of technological issues and personal relations; technologically this means the consistency and authenticity of data. Two concepts are available to ensure this: protection and validation. Protection works on the hardware side (e.g., access control, fire protection, using a UPS (device a machine which supplies energy in the case of a power blackout, etc.) and on the software side (anti virus, firewall programs, etc.). Conceptually both hardware and software systems are planned and set up together. Policy can give advice here, but overall companies ensure hardware and software protection on their own, signalling this to outsiders (through using ISO-certificates, for instance).

The concept of validation is to prove that the data transmitted is true. Three methods already employed are the use of certificates (on websites transferring data via https), the use of public and private keys to encrypt data, predominantly used for e-mail, and a combination of hardware and software based identification (e.g., the use of smart cards for banking transactions). One political instrument to promote electronic trade would be to provide a European smart card identification system. A European digital trust centre could provide an official electronic identity smart-card and PIN-code algorithms to verify identity. On the other hand, privacy and consumer protection issues must be carefully considered because of the dangers of data mining and other forms of misuse.

At the individual level, trust can be supplied by countries (governments), companies and households. At a household level trust is one prerequisite for private relationships. On a country level, this means establishing an effective set of policies. This is also one argument for the restarting of the EU-confession process.

At the company level, building trust is part of the branding strategy. A brand encompasses a set of characteristics, especially trust in the quality of products and services which is a key element of a brand. For B2C-products establishing a brand is a marketing task with trust often being built initially on a vis-a-vis basis. In the case of international outsourcing Euroitx (2005), a study compiled for CBI (Centre for the Promotion of Imports from developing countries) gives the following advice to overseas companies trying to win a (west) European customer:

- Focus on one area and specialize in this area in order to supply the client with an outstanding service.
- Focus marketing on core sectors and niches; look to visit specific outsourcing events.
- Explore cooperation possibilities with other companies, trade and/or promotion organisations.
- Go online, having an official website.
- A foreign national within the client company in the EU could very well favour outsourcing.
- Look at the quality standards required in EU. The most important of these are the ISO 9000 system and CMM (capability maturity model). Although Euroitx (2005) argues that considering the standards "may save exporters in developing countries many hours and much effort in proving their capability to EU cli-

ents," the quality standards are discussed in the section "non-tariff trade barriers" found in this study.

Cultural aspects are also an important component when building trust. The most sustainable way of maintaining trust, however, is with an established and successful relationship, despite cultural differences. From this point of view, international outsourcing may favour further international outsourcing projects.

2.3.4 Knowledge and Scale-Intensity

Due to marginal costs close to zero, digital goods show high economies of scale. Examples are music files (e.g., .mp3, .wma, .rm files), mobile ring tones, electronic books (or scientific papers) and standardized software. When combined with additional – often complementary – services, the picture becomes less clear.

The knowledge-intensity of digital goods and services is high in general, but two exceptions should be mentioned. First, ICT technology simplifies services such as data entry. Second, the love of variety on the demand side creates markets which are not knowledge-intensive per se. Web-Design is an example of a service with average knowledge-intensity although specific skills are needed for it. Fig. 8 shows the knowledge and scale-intensity of selected digital goods and IT services:

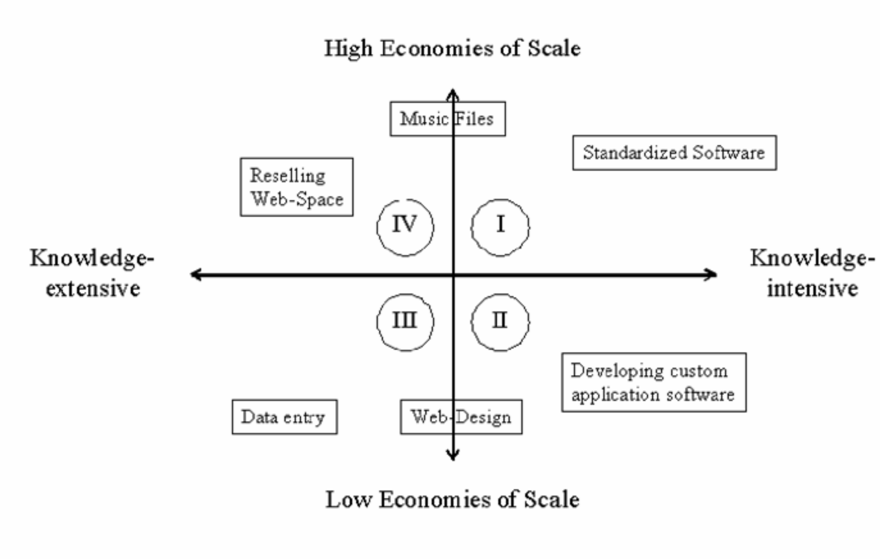


Fig. 8. Scale- and Knowledge Intensity of Selected Digital Goods and IT Services

Regarding these characteristics, this leads to the question of the impact they have on the market structure and the internationalisation of digital goods and services. The hypothesis is that factors favouring monopolization also favour internationalisation.

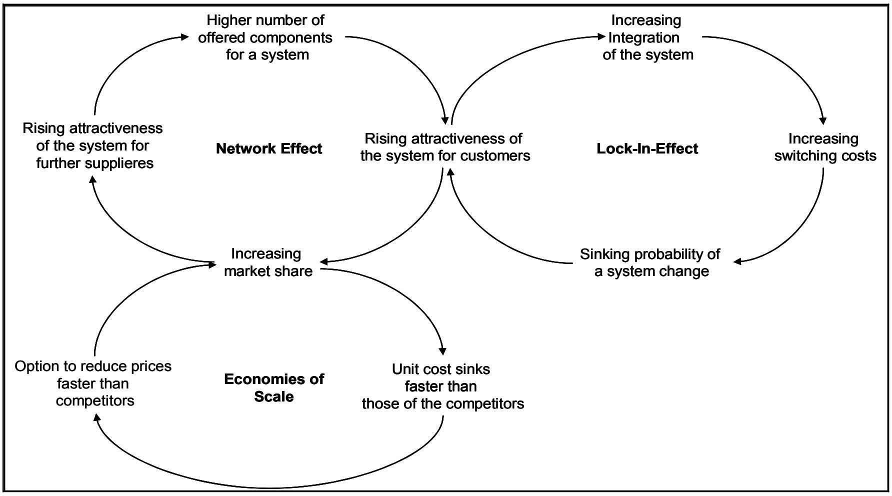
2.3.5 Market Structure and Internationalisation

Due to the fact that IT Services and digital goods can be transported by Internet Protocol (IP) based networks worldwide, thereby negating the importance of location, the argumentation here immediately becomes global in nature, extending beyond a regional or international view. The borderline for each market segment is therefore to be a global monopoly or global polypolistic competition (polypoly) respectively. The global polypoly encompasses the local polypoly. The sustainability of a local (or regional) monopoly, which decrees only one (few) local market(s) in one (some) specific country (countries), can be ruled out, because it is vulnerable to other IP-based internationally-located competitors.

Therefore, the question of internationalisation is reinterpreted as a question of market structure here. Factors favoring monopolization also favor internationalisation. The questions are thus: which idiosyncrasies of IT Services and digital goods force monopolization, and which characteristics lead to a more polypolistic market structure? When interpreting the results, we must also consider the Schumpetarian view that no monopoly will last forever because "creative destruction is the essential fact about capitalism" (Schumpeter (1942)).

Driving Forces Towards Monopolization

Besides scale effects, other factors also favor monopolization. Fig. 9 shows the interdependencies:



Source: Müller et al. (2003), translation by author

Fig. 9. Monopolization Drivers Favouring Globalization

- Scale effect: Increasing the quantities produced lowers thereby the average costs. This improves the competitive position and the opportunity to put rivals out of the market.
- Network effect: An IT service is more attractive when more users are connected.
- Lock in effect: Customers are bound to systems due to changing costs. Smith et al. (2000) refer to the similarity of loyalty programs used by airlines and argue that the familiarity with a retailer's site is a form of switching cost.

Other authors stress that ICT use allows for fine-grained observation and analysis of consumer behaviour. This permits various kinds of marketing strategies, for example, for differentiated goods and prices (Varian (2004)). Versioning can also be a price discrimination strategy. Types of versioning are: delay (e.g., publishing stock quotes), user interface, convenience, image resolution, speed of operation, flexibility of use, capability, features and functions, comprehensiveness, annoyance (start-up delays of reminders), and support (Varian (2000), Shapiro/Varian (1998)). This leads, for example, to time based pricing, disaggregation of previously packed content, or bundling of products.

Although the role of versioning is not proven in all cases (more niches markets may also attract more innovative competitors), the danger of monopolization is all the greater, the more these effects aggravate each other; for example, scale economies may result in the survival of only one network among the conceivable alternatives (Liebowitz/Margolis (2002)).

Driving Forces towards the Market Structure of Polypolistic Competition

In contrast to factors favoring monopolization, factors also exist which favor competition in digital goods and IT services. The most important of these are:

- Love for variety; Diversity is related to B2B and B2C products as well. This also includes products with different knowledge-intensities.
- Altruistic and intrinsic behavior to prevent monopolistic power (e.g., the open source movement).
- Schumpeterian view: Technological change that attracts innovative competitors or opens possibilities to bypass existing systems ("subversive technologies" like VoIP); monopolies are not sustainable.
- Institutional barriers (e.g., national tax laws or rules for invoicing and language barriers); these barriers might favor local monopolies, but prevent global ones.

It should also be conceded that the previously mentioned forces towards monopolization might not be all-dominant. Kling/Lamb (2000) point out that firms such as amazon.com could not have functioned on the Internet alone, rather they rely on financial (credit cards) and distribution infrastructure as well, thereby limiting market power. Moreover, agents in a network act more heterogenously than homogenously. These arguments directly attack the proposition that networks drive monopolization. Carley (2000) mentions three reasons. First, emergent behavior means that the behavior of groups, organizations, and markets cannot be predicted by looking at average behavior. Second, path dependence argues that what individuals learn is a function of what they currently know and who they know. Individuals with different backgrounds learn different things when faced with the same new information. Finally, the inevitability of change require that individuals continuously learn. This leads to changes in information, knowledge and job networks. Additionally, the role of intermediaries in electronic markets shifts will not be completely removed, rather they will take new roles such as helping in market information (Smith et al. (2000)).

Internationalisation therefore means enhancing chances to stay in a market exploiting economies of scale, network and lock in effects. From a Schumpeterian perspective, however, it is also true that new competitors will enter the stage. From a theoretical point of view, there is no reason why one or the other driving force may be dominant. We can therefore reconcile permanent internationalisation efforts at the firm level with a polypolistic market structure from a theoretical point of view as well. In like manner, the economic theories of product differentiation and fragmentation examine the possibilities of exploiting scale effects without organizing the whole value chain in merely one company (Arndt/Kierzkowski (2001)).

This is particularly true when single market segments are considered. The dominance of Microsoft in the market of PC operating systems is associated with a polypoly of PC manufacturers whereas the production of computer processors is dominated by two firms. This market structure is not predictable in general, but two technical constellations can be differentiated:

- The market segments are independent from a technical point of view. For example, data does not change when sent via the Internet. The more independent products are from other products, the more their producers will be able to exploit scale, networks, and lock-in effects.
- The market segments interact, standardized modules and interfaces are employed. A good example is the API (application programming interface) structure which provides the connection between the two complementary goods, hardware and software. For example having property rights of an API also means having the possibility to have some market power on a related market. This may lead to "internationalisation by licensing".[3] Furthermore, software platforms play an important role in computer based industries. Evans et al. (2005) compare the markets of personal computers, video games, PDAs, smart mobile phones, and digital content devices (Apple's ipod), identifying very different pricing strategies despite a similar technology. An overview of two sided markets characterized by network effects on both sides is offered by Roberto (2005).

Summarizing, the relevant markets are more global than local unless institutional barriers impede. The more standardized a product is or if different versions can be produced easily, the more probable a monopolistic market structure is,

[3] In Linux systems the APIs are part of the kernel and therefore open source as well. Apparently the Japanese electronic companies Fujitsu, NEC, and Hitachi now want to introduce an API interface outside the kernel, so that they might be able to give away drivers for their machines as a closed source software (Heise-News (2005)).

which then tends to favour a global monopoly in that segment. On the other hand, Schumpeterian dynamics are a strong competition driving force. Strong competition, however, also requires that all advantages of global integration (scale effects) be exploited. From this perspective, EU liberalization of telecommunications has stimulated internationalisation of part of the ICT sector Gabrielsson/Gabrielsson (2003).

This argumentation focuses on the microeconomic tool of economies of scale, but the macroeconomic setup of an economy and technological development also play a role. Arora/Gambardella (2004) explore the factors needed to become a successful software producing country in general and find that countries showing 'signs of vitality':

- have a higher share of educated population compared to their level of development;
- do not have a wide and diversified industrial basis, which implies lower opportunity costs of these people to work in the software industry;
- have domestic sources for the formation of software competencies (like Nokia in Finland);
- believe in the importance of openness, thereby favouring 'free trade' and an openness to multinational companies (MNCs).

The future development of international production sharing will be influenced by technological improvements as well. Even if companies accelerate international outsourcing efforts, Carr (2005) predicts that four technical factors drive the centralization of IT Services:

- Virtualization, which erases the properties between computing platforms from the users' point of view.
- Grid computing: large number of hardware components which act as one device.
- WebServices: standardized interfaces between applications. Mcafee (2005) describes WebServices as replacing interactions between humans and applications with interactions between applications only.
- Fibre optics networks for quick access to large data volumes.

A hypothesis which should be addressed by future research is that more concentrated regionally IT Services centers will arise. This would correspond to the result of Rubalcaba-Bermejo/Gago-Saldana (2002), who analyzed regional concentration with data from France, UK, Austria, Belgium and Finland in 1997, finding that the business services economy is closely linked to urban density, national profiles and other regulatory and instructional factors. At the same time, however, it is also linked to a degree of exposure to international competition. So capital regions benefit from the highest presence of business services as they are the most global regions. Rubalcaba-Bermejo (2004) argues that many international flows in services require a local presence and that local providers are the ones who can 'glocalise' international services. This may be true for IT services as well.

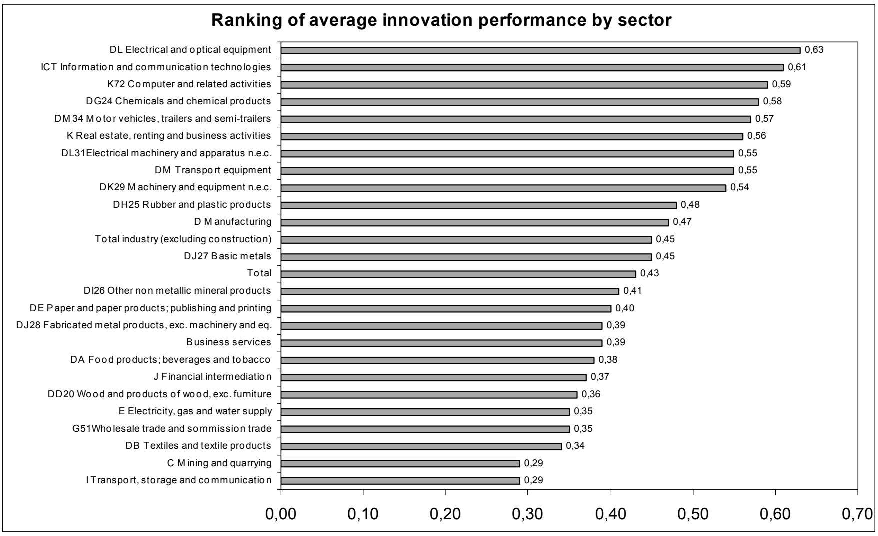
2.4 International Outsourcing of ICT, Innovation and Foreign Direct Investment

From a theoretical perspective, international outsourcing of ICT is important for cases in which international fragmentation allows for the exploitation of considerable factor price differentials; this holds particularly for ICT products with economies of scale if the final product is relatively price sensitive. If dynamics scale economies (e.g., case of computer chips) also play a role, full exploitation of scale advantages requires market access to large OECD countries. An ICT-specific trait of internationalisation of ICT production is the fact that ICT goods are largely weightless goods so that transportation costs are not really important. From this perspective, one should expect that international outsourcing potentially puts the focus on many countries whose locational conditions are competing for mobile ICT investors. To the extent that one considers goods which are both knowledge-intensive and scale intensive, one may anticipate that part of value-added will be in one or several of the leading OECD countries as adequate skill-intensity is found only there; at the same time, the economies of scale aspect in, say, the manufacturing process implies that only one country (or a very small number of countries) will be attractive for foreign investors from the ICT sector. According to the concept of fragmentation, one may anticipate that every new product cycle once again raises the issue of how to organize international outsourcing/offshoring, that is how to best split the value-added chain.

From the OLI-perspective of Dunning (1958, 1972, 1973, and 1977), we expect that high technology ICT activities should particularly be characterized by offshoring. According to the Dunning approach, ownership specific advantages of firms – in particular technology-based advantages – are an important basis for successfully producing abroad: The foreign investor has to overcome the natural competitive advantage of indigenous firms. As markets for technological information (in particular, markets for patents) are rather imperfect, the basic alternative for serving foreign markets is exporting or foreign direct investment (in the sense of producing final goods abroad).

ICT broadly defined is indeed a strong driver of innovation dynamics in OECD countries. According to the European Commission’s European Innovation Scoreboard for 2006 (see Fig. 10), electrical and optical equipment, ICT information and communication technologies as well as computer and related activities show the highest ranking of average innovation performance by sector. This indicates a strong relevance of ICT for growth and structural change; R&D activities in ICT are strongly internationalized in some sub-sectors, including software development. (The US, the EU, China, India and Japan are strong centers of software development; some of the US firms’ and EU firms’ activities in China and India partly reflect the search for comparative advantage and cost-cutting, yet there is also pressure by governments of these big countries, namely to give access to markets only under the condition that firms establish a development center.)

A specific characteristic of several technology-intensive activities of ICT production is the shortening of product cycles (e.g., in the chip sector). The implication is that the international offshoring patterns – partly combined with outsourcing dynamics – accelerate. As countries in Asia and Eastern Europe are catching-up technologically, one should expect a rather unstable international offshoring pattern in the relevant ICT sub-sectors. With every new product cycle, there could be a new geographical offshoring sequence. However, R&D activities can be expected to be rather immobile, since they require high knowledge intensity. Thus the leading OECD countries have a considerable comparative advantage in terms of the availability of both skilled labor and human capital.



Source: European Innovation Scoreboard (2005), S. 23

Fig. 10. Sectoral Innovation Performance in the EU

Differential Offshoring Patterns

Not all subsectors of ICT are natural and stable candidates for offshoring. Recent research on the internationalisation patterns in German industries (Kinkel/Lay, 2004) has indeed shown that some sectors have experience in not only offshoring but in backsourcing as well. As for the latter, the net benefits from producing abroad do not match expected results; the survey results from the Fraunhofer Institute indeed show different patterns for different sectors. One important feature is that the tendency for offshoring is weak in both the case of rather simple products and in the case of very complex products. As regards very complex products, it is obvious that Germany is well endowed with skilled labor, having a long history in the production of technology-intensive/knowledge-intensive products so that one will not easily find profitable alternatives abroad. A similar finding indeed holds for most Western European EU countries (with a caveat with respect to cohesion countries); the region is well endowed with skilled labor. The finding that simple products are less often offshored than products of medium complexity largely seems to reflect that fact that offshoring is not really an alternative for simple products. If the respective firm has a sustained competitive-ness problem, it is likely to shut down production as demand in the home market can easily be covered through imports. The subsector electrical components was quite stable in terms of offshoring, and the ratio of backsourcers to offshorers was rather low (around 7%). The propensity for offshoring in that industry was similarly high – the share in all outsourcers was close to 35% –, as was the case in the top group radio and TV equipment, computers and office equipment. However, the ratio of backsourcers to offshorers here was about 20%. The highest share of backsourcers was in chemical industry (close to 40%). By contrast, medical and optical equipment as well as precision instruments had a medium offshoring propensity but showed a rather low share of backsourcers (about 13%). These were found to be relatively stable in terms of internationalisation. The results show that ICT international offshoring is a rather important and also relatively stable phenomenon. Once a sector has left a certain EU country, one should not expect a high share of backsourcing.

As regards offshoring, the main motive was related to relative production costs, followed by the desire to create new markets, to have more flexibility in meeting market demand abroad and to produce closer to main customers; aspects related to taxes and subsidies also played a role. Two major motives for backsourcing were quality problems encountered abroad and high coordination costs.

These findings suggest that considerable potential for offshoring in high wage EU countries exists. Given EU25 factor price differentials, one should expect that EU accession countries – with low wage costs – stand to benefit from part of the international relocation of ICT activities in leading EU countries.

The expansion of ICT is strongly linked to computer technology adoption and the use of powerful software and fast communication tools. As such, the division of labour within a firm as well as across firms is affected. Product cycle trade should play a particularly strong role in ICT goods, including both Fordist sectors with high economies of scale and limited knowledge intensity as well as Schumpeterian Fordist sectors with a combination of economies of scale and knowledge-intensive production. In Schumpeterian Fordist sectors, fragmentation in combination with offshoring is likely to play a particular role since leading innovative firms from OECD countries will be hesitant to allow broad international knowledge transfer to competitors. The stronger the intensity of price competition is the stronger will be the pressure for broad international outsourcing. Hence the low quality segment of the mobile phone market (handsets) has witnessed stronger international outsourcing dynamics than the high end of the market (see the example of Nokia). As regards digital services markets, one should be aware that WTO liberalization in services markets is more limited than in goods markets, which gives governments in large countries such as China or India some leverage in the field of software producers: State-owned firms and government agencies are more likely to buy digital services (e.g., software) if the service provider is willing to assign part of R&D activities to the respective country. Leading software companies such as Microsoft and SAP are thus likely to create software labs in China and India. This willingness is certainly enhanced by the increasing availability of skilled personnel in these countries. Moreover, one should take into account the specific pressure in sectors with short innovation cycles, namely to organize 24 hour global R&D activities in a triadic multinational network.

Borghans/Ter Weel (2005) analyze the division of labour under the impact of ICT technological change: Their model explains the differences in the division of labour across firms as reflecting computer technology adoption. Changes in the division of labour are found to result of:

- reduced production time which shifts the division of labour towards a more generic structure;
- from improved communication possibilities which enhance specialization;

Based on a sample of Dutch establishments in the years 1990-96, the authors find that productivity gains have been the main determinant for shifts in the division of labour within most firms with productivity gains inducing skill upgrading. In companies profiting mostly from improved communication possibilities, specialization increased and skill requirements fell.

If this pattern were also observed on an international scale, the structure of industry would be quite crucial since a dominance of sectors, with reduced production time would coincide with skill upgrading and rising unemployment of unskilled labour or falling relative wage rates of unskilled labour. Countries whose industries are mainly enjoying improved and cheaper international communication possibilities could face increased specialization, while the skill requirement could fall, possibly contributing to a long term undermining of innovativeness to the extent that innovation dynamics and human capital are complementary. In the liberalized post-1998 EU telecommunications markets – for which there has been both a fall in national and international communication costs –, for example, it is a priori unclear whether more competitive EU telecommunications markets imply pressure towards more international outsourcing.

The ICT sector has been characterized by high technology dynamics for decades. In terms of the growth rate of patent applications in the 1990s, telecommunications was the fastest growing field at the European Patent Agency. Liberalization of the telecommunications sector in Europe and many Asian countries has obviously contributed to this. Moreover, with partial or full privatization of former monopoly operators in fixed telecommunications and the opening up of national markets in EU member countries, there has been rapid internationalisation through both rising foreign direct investment and growing trade in telecommunications equipment and digital services. The role of multinational companies in both fixed line and mobile telecommunications services increased in the 1990s. The fall of communication costs brought about by a combination of technological progress and intensified competition has stimulated national and international networking.

As regards the expansion of multinational firms in OECD countries, there is a general tendency for MNCs to build larger integrated networks for technological development. As Cantwell/Piscitello (2003, p.14) contend:

"In each location in such a network MNCs tap into specialized sources of local expertise, and so differentiate their technological capability, by exploiting geographically separate and hence distinct streams of innovative potential. The recent emergence of integrated MNC networks is best observed in Europe, where the contribution of foreign-owned MNCs to national technological capabilities is greater than elsewhere. About one-quarter of large firm R&D carried out within Europe has been conducted under foreign ownership, while the world average is only just over one-tenth."

The result of the empirical analysis of Cantwell/Piscitello (2003), who studied the relative attractiveness of European regions in becoming an element of an MNC network, can be summarized as follows:

- MNCs look for positive spillovers and thus emphasize intra-industry spillovers or specialization externalities stemming from firms of the same sector
- MNCs also try to exploit inter-industry spillovers or diversity externalities associated with innovative firms from other sectors
- MNCs locate network activities with science-technology spillovers and externalities associated with the presence of an adequate scientific or educational infrastructure.

This is new empirical evidence that part of foreign direct investment dynamics is driven by asset-seeking investment. ICT expansion and the growing increase in powerful digital computer networks facilitate the creation of large international networks.

From an EU perspective, it is obviously important that the national innovation systems and modernization of the education sector as well as modernization of the telecommunications network set positive incentives for MNCs to locate crucial production and innovation activities in the EU and that these developments create a potential for insourcing. EU countries are not only involved in ICT outsourcing; indeed, in the field of business services there also is considerable insourcing.

The biggest world relative insourcers (for business services and computer & information services) and the biggest surplus and deficit countries are listed by Amiti/Wei (2005). In 2002, the top insourcers in business services were the US, the UK, Germany, France, the Netherlands, India, Japan, China and Russia. As regards computer & information services, Ireland led the list, followed – with the exception of Spain – roughly by the same list of countries as before. The relatively biggest insourcers of business services (relative to local GDP) were Vanuatu, Singapore, Hong Kong, Papua New Guinea and Luxembourg, which recorded business services outsourcing in the range of 17 to 10% of GDP. India ranked in at 21, the UK 33, 50 for France, 54 for Germany, 79 for China, 88 for Russia, 90 for the US, 95 for Japan. The average share of the UK (2.35%), France (1.45%) and Germany (1.40%) was more than twice as high as the share of the US of 0.58% of GDP. Hence even under the assumption that leading EU countries' insourcing represents half of the insourcing from other EU countries, the combined position of the UK, France, Germany is favorable. As regards computer and information services, Ireland, Cyprus, Luxembourg, Costa Rica and Belgium were the top 5 (with a range of 8.5% to 0.8%), with the UK achieving position 17, German 24, 42 for France, and 49 for the US. Thus one may state that for some of the small open economies in the EU, there has been relatively successful insourcing which reflects a particular specialization in ICT services. As regards large countries it is not surprising that insourcing figures are rather small relative to GDP. Most of regional outsourcing in a large economy – in contrast to that found in small open economies – is regional insourcing.

At the beginning of the 21st century, the biggest surplus countries in the field of business services in the world economy were the UK ($ 20.6 bill.), the US, Hong Kong, India and Singapore (followed by China). In computer & information services, these were Ireland, the US, the UK, Canada and Spain. The five largest deficit countries in the field of business information were Korea, Japan, Indonesia, Germany, Ireland; in the field of computer and information services, China, Italy, Germany, Japan and Brazil.

Thus the picture at the beginning of the 21st century is inconclusive, and one may draw only the following preliminary conclusions:

- Some EU countries are major insourcers of ICT services
- Some EU countries have a considerable sectoral deficit position in ICT services
- Some Asian countries seem to play a considerable role as successful net exporters of ICT services. From this perspective, it will be interesting to observe whether subsidiaries of EU ICT multinationals are among the driving forces of those surpluses. If there were such a sustained phenomenon, one may assume that international ICT outsourcing of EU firms reflects a win-win international division of labour in the digital world economy.

For further estimations of the volume of international outsourcing see also OECD (2004c), although the report reveals enormous statistical discrepancies, exemplary for the case of India. Kirkegaard (2004) explores the case of the US-India trade balance in detail and describes several reasons for the discrepancies. Nevertheless the OECD (2004c) report emphasizes that cultural similarities are important for international outsourcing, noting that international outsourcing has been dominated by American and British companies which offshore operations to India, Canada and Ireland. Another OECD report (Van Welsum/Vickery, 2005) directly confesses that "little is known about the impact and extent of international outsourcing' by official statistics. But it states that 'anecdotal evidence suggests that the international sourcing of IT and ICT-enabled services is growing rapidly' and estimates that 20 percent of total employment in the EU15 could potentially affected by the international sourcing of service activities. Mann (2005) points out that outsourcing not only influences the number of IT jobs but also the mix of IT skills demanded - 'with a greater emphasis on integrating imported components, and analyzing, designing, and implementing IT products."

The WTO (2005) draws attention to the rapid growth of world exports of computer and information services, which was 31 per cent (cumulative) over the 2002-2003 period. Ireland and India are identified as the two major exporters of computer and information services in 2003. According to EITO (2005), off-shoring services are defined as services sold in Western Europe but delivered from lower-cost countries (such as Czech Republic, Poland, Slovakia, Russia, India, China, South America). This represents some 1.1 per cent of total IT service spending in Western Europe. It is further estimated that this ratio will increase to 1.8 per cent in 2008. Overall, the EU (2005) presented simulation results which state that the "net effect of globalisation-induced changes in international production patterns is extremely small for the EU with any localised losses in specific sectors being offset by gains elsewhere in the EU's economy."

These numbers show that ICT diffusion and progress in ICT products facilitate a flexible international slicing of the value-added chain and thus reinforce the opportunities for international outsourcing and offshoring. One should thus anticipate that there will be increasing vertical trade within the EU25, but rising global fragmentation as well. In fields for which human capital formation and a well-established innovation record are prerequisites for profitable ICT capital accumulation, there are obviously limitations to outsourcing from an EU25 perspective.

As regards structural change and economic modernization, theoretical and (with respect to Poland, Hungary and the Czech Republic) empirical arguments suggest that the modified revealed comparative advantage of industrial sectors is a positive function of the inward FDI capital stock and of the relative unit labour costs (Welfens/Borbely, 2006). Moreover, one may assume that sectoral FDI inflows – which have increased over time in ICT sectors in accession countries – are a positive function of sectoral RCAs, sectoral export unit values and import RCAs, which implies that countries which specialize successfully while relying in an adequate manner on imported intermediate products will attract high foreign direct investment inflows. The theoretical argument basically says that countries offering (sectoral) opportunities for using intermediate imports in a dynamic context, namely as an element to foster relative sectoral exports, will stimulate profit-seeking, asset-exploiting foreign direct investment.

As regards economies-of-scale intensive sectors with low knowledge-intensity, it should not be very difficult for eastern European accession countries to attract FDI inflows from western Europe, the US and Japan. At the same time, one should not rule out that dynamic globalization could lead eastern European EU countries to begin outsourcing and offshoring to low wage Asian countries in due time.

International Alliances

As regards international alliances, the emphasis is more on EU15 countries than on EU accession countries. Strategic R&D alliances played an increasing role in the EU in the late 1980s, as globalization and the run-up to the single market programme as well as higher EU funds for cooperative R&D projects stimulated the internationalisation of European R&D (Narula, 1999); the IT sector and biotechnology played a particular role. Moreover, there have also been renewed dynamics in R&D in the form of both asset-exploiting and asset-seeking FDI in the EU and the US. Criscuolo/Narula/Verspagen (2005) argue that the capacity of R&D facilities to exploit technological competences is a function of not only their own resources, but the efficiency with which they utilise complementary resources associated with the relevant local innovation system. The empirical analysis indicates that both EU (US) affiliates in the US (EU) rely strongly on home region knowledge sources, although they appear to exploit the host knowledge base as well. The crucial emphasis on home knowledge raises doubts about a potential R&D strategy of the EU which would neglect the EU countries as prime locations for leading edge R&D in technologically dynamic sectors, in particular the ICT sector. One must also raise consider the extent to which an expansion of ICT requires reforms of the innovation system and in particular a stronger role of virtual research networks and "Digital Universities". Optimal linkages between R&D facilities and firms in technology-intensive sectors are crucial and naturally include foreign investors.

2.5 ICT Product Cycle

Both globalization and EU eastern enlargement have stimulated international outsourcing, namely in the sense that a multinational company would buy intermediate products from other firms abroad or that the MNC would set up new foreign subsidiaries and obtain intermediate products through rising intra-company trade. The ICT sector has been part and parcel of the international outsourcing process. ICT sector dynamics have broad economic significance. They affect many sectors, because so many use ICT products or ICT services. This implies strong competition, which in turn stimulates the cost-cutting reorganization of industries and national or international outsourcing dynamics, part of which concerns the ICT sector itself. Moreover, one may expect four impulses for rising internationalisation in the sense of growing trade.

According to Vernon (1966), the first stage of the product cycle is characterized by R&D and is a first phase of production in a technologically leading OECD country ("pioneer country"), where the firms focus on the domestic market and only partly on increasing exports to other high income countries; this implies a positive sectoral trade balance. In the following standardization stage, production is relocated to a medium-income country ("intermediate country"), and the pioneer country will start importing the respective good so that it will face a negative sectoral trade balance. In the final maturity stage (when cost advantages in a highly competitive global market play a crucial role), the product will be produced in developing countries. The trade balance of the pioneer country and the intermediate countries are negative and that of the developing country becomes positive. In the product cycle approach, foreign direct investment clearly plays a crucial role with FDI dynamics being linked with trade dynamics.

The ICT sector is an expanding field in its own right, as novel digital products and services are created in a dynamic networked world economy: The internationalisation of the ICT sector thus has to be analyzed not in the least from the perspective of the product cycle trade approach (Vernon, 1966). According to the evidence presented, the ICT sector in the EU is shaped by very high innovation performance. Taking into account previous innovation scoreboards, it seems that the innovation dynamics in the ICT sector have intensified so that product cycles have shortened. This would explain the relatively strong pressure in a large range of ICT products to more strongly exploit international outsourcing and offshoring opportunities since better exploitation of international cost differentials is a natural way to make sure that R&D costs can be recovered over the shortened production cycle. As such, an adequate profit rate be achieved. Better exploitation of international cost differentials suggest on the one hand a more timely relocation of activities in the various stages of the product cycle. On the other hand, a more aggressive search for internationally profitable fragmentation opportunities is also relevant. In ICT subsectors with static or dynamic economies of scale, one should particularly expect a higher propensity to internationalisation and indeed to increasing fragmentation.

In the ICT sector, shortening product cycles and high technological dynamics have encouraged firms to concentrate on core competences and to rely more on intermediate products supplied by rather specialized firms: The key suppliers are those with whom the final goods producer has long term contracts. In contrast, second-tier suppliers are less specialized; hence the contracts between the final product firm and those suppliers are more short term in nature and are strongly focused on price competition as was emphasized by Paija (2000) for the case of the Finnish ICT cluster. This also is in line with the logic of transaction costs theory, according to which long term contracts are more crucial for fruitful cooperation:

Part of ICT products are weightless goods in the sense that transportation costs are relatively irrelevant (e.g., the case of electronics products). This implies that within the group of countries well endowed with skilled labor – basically OECD countries as well as a few Newly Industrializing Countries –, there will be strong locational competition. If the respective country has a large home market or has large customers, ICT products with scale economies are rather likely to be partly relocated to the respective countries showing the combination of high market volume and broad availability of skilled labor.

Internationalisation of ICT basically concerns on the one hand the fragmentation of ICT production and on the other hand the fragmentation of ICT services. Here fragmentation means vertical disintegration of the production process or the provision of services. Vertical disintegration is strongly visible in international trade (WTO, 1998) as there is much international outsourcing and offshoring. An intermediate link – amounting to quasi-FDI – between the final goods producer and the foreign supplier firms is realized if there is long run subcontracting which establishes a firm link between producers of intermediate inputs and the final goods producer. Helper (1991), Gardner (1991), Bardi/Tracey (1991), Bamford (1994) and Abraham/Taylor (1996) have analyzed the increasing role of subcontracting for various industries including ICT sectors.

The higher the degree of technological sophistication of a product (of innovative goods and services), the more important it will be for the final product producer to keep full control of the quality delivered from foreign suppliers on the one hand and to avoid technology leakages through such suppliers on the other. FDI as an element of international outsourcing will become more important:

- the higher the technology intensity of the product or sector concerned is;
- the lower the transportation costs are.

Both elements play a crucial role in the electronics industry, and several interesting case studies are available in this field (Görg/Ruane, 1999, Bresnahan/Greenstein, 1997) which focus on the electronics industry. An interesting observation is that the various processing stages (labour intensive, R&D intensive) are carried out in different countries. For example, chip design is done in the US, simple stages of chip production are made in Malaysia and the rather complex chip production is in Ireland or in eastern Germany or Hungary. An interesting aspect of the internationalisation of European ICT concerns the question of whether the new member countries will strengthen EU ICT dynamics. In particular this raises the question as to whether those countries will be able to achieve an improving and "satisfactory" revealed comparative advantage (RCA) which indicates the relative export-import position relative to the overall export-import position of the respective country. Successful product upgrading (visible in rising long term export unit values) would also indicate a positive development in accession countries. A rise in the RCA over time and a rise in the export unit value will both stimulate expansion of the respective sector. To the extent that ICT goods and services are considered important for long run growth and productivity improvements, it would be useful to have an expansion of the ICT sector – at least of the more sophisticated sub-sectors – by employing highly skilled labour or allowing the exploitation of considerable scale economies. Thus the EU would be interested in having:

- member countries – or the overall Community – with ICT sectors with an RCA exceeding unity; as long as ICT is a high-technology sector, one may indeed assume that positive specialization on ICT will go along with a growth bonus.
- member countries with ICT sectors in which firms can raise export unit values in a sustained manner; the use of ICT indeed facilitates product differentiation and quality improvements. Both should enable countries to fetch higher export unit values in many ICT intensive sectors.
- an adequate mix of ICT production – known for its high rate of technological progress – and an increasing use of ICT in a productivity-enhancing way.

As regards the analysis of the internationalisation of European ICT activities, a triple analytical challenge deserves mentioning, namely an interest in:

- Theoretical analysis of outsourcing in general; to this general theory we will have to add the specific aspects of ICT. Outsourcing dynamics can be analyzed both in a microeconomic and a macroeconomic perspective.
- Foreign direct investment dynamics: Here we will have to consider both FDI inflows and FDI outflows and to the theory of FDI dynamics one will have to add the specific aspects of ICT from an EU perspective.
- Present and future EU integration dynamics, which requires consideration of the 2004 EU enlargement and additional eastern enlargements (creating an even wider single EU market) in the future, characterized by a considerable intra-EU east-west digital divide.

ICT is a field which is partly knowledge intensive, scale-intensive and technology intensive. From that perspective we expect the ICT sector to be largely characterized by imperfect Schumpeterian competition among multinational firms eager to translate technological/ownership-specific advantages into profitable production in various countries. Since the late 1970s, multinational firms have extended their fields of innovation competence through the use of internationally integrated networks for technological development and innovation. This raises the topic of how MNCs are adjusting their international networking in the digital age.

ICT is also R&D intensive and thus the issue has to be raised about the extent to which R&D is internationalized in the ICT sector itself or in other industries (on the basis of ICT use). Narula (2000) has revealed a growing use of non-internal technology development, both by outsourcing and strategic alliances, but it seems that large firms have benefited more from globalization than traditional small and medium sized enterprises.

There is little doubt that EU accession countries, with a rather well educated workforce and considerable efforts in network modernization in the telecommunications sector, are attractive locations for international outsourcing and offshoring in the medium term. As regards EU15 outsourcing activities, one may also anticipate that North African Countries could benefit in the long term, provided this region adopts adequate modernization policies (Gianfranchi /Rossotto/Burtin, 2005).

3 Theoretical Perspectives on Internationalisation

3.1 Standard Theoretical Perspectives on ICT Goods and ICT Services

Recent analysis (Borbely, 2006) has brought empirical evidence that EU eastern enlargement is associated with dynamic Heckscher-Ohlin type industrial adjustment and trade specialization patterns which include both labour intensive and technology intensive goods (among those are differentiated products which come close to the group of ICT goods). It has been shown that there is a significant positive correlation between industrial production and comparative advantage. The revival of industry in EU accession countries, typical after the first transformational recession/crisis, will therefore go along with a rise in industrial production and an improved comparative advantage in the respective sectors. Hungary and the Czech Republic were found to have improved the RCAs in some knowledge-intensive fields of production in the late 1990s. Poland, Hungary and the Czech Republic attracted considerable foreign direct investment inflows – including in sectors with economies of scale – and thereby improved export unit values over time. The upgrading of products has obviously been facilitated by foreign direct investment inflows. As regards electronic products/differentiated products, one may argue that EU15 outflows of foreign investment to accession countries is a major driver of structural change in Europe. It is not surprising that accession countries have been able to attract knowledge-intensive production in several fields, since several accession countries are relatively well endowed with skilled labour.

From an EU25 perspective, relocation of part of ICT production to accession countries should be considered a normal element of single market dynamics. However, one should be aware that sectors characterized by high economies of scale and low knowledge-intensity are indeed rather footloose. Components whose production has been relocated to eastern Europe and which look like a success story in accession countries could easily be relocated to countries in Asia or other low-wage regions. This holds all the more if accession countries face high wage increases and a rise in unit labour costs after several years of high growth. From this perspective one may argue that eastern European accession countries can be expected to mainly focus on goods shaped by price competition in the medium term. In the long run, however, the range of sectors mainly characterized by quality competition is likely to increase. This in turn raises EU-wide challenges for education policy and retraining activities.

Moreover, export unit values were found to play a major role in explaining comparative advantages so that product upgrading and product innovations stimulate sector net exports. However, the export sector should not be considered in an isolated manner, rather import shares and export shares are strongly positively correlated in high-technology sectors; foreign direct investment is positively correlated with labour productivity and industrial production; and R&D expenditures have a positive effect on total manufacturing exports. Hungary and the Czech Republic achieved a comparative advantage in the late 1990s not only in some labour intensive sectors but also in the fields of differentiated products and knowledge intensive products. At the bottom line, one may emphasize that Eastern European accession countries recorded strong revealed comparative advantages (RCA) in labour intensive products, but over time also achieved a positive RCA in science-based sectors and in differentiated products.

These findings for the manufacturing industry let us expect that in the course of EU eastern enlargement and the unfolding of the EU25 single market, a rising share of intra-EU outsourcing in ICT goods will be observed. Moreover, other sectors of at least some eastern European accession countries can also expect to see growth of industrial production and rising comparative advantage. With respect to ICT goods, we therefore expect in some sectors increasing outsourcing towards EU accession countries, and this process will be shaped by rising foreign direct investment in these countries.

The above empirical findings may lead to a refined "Heckscher-Ohlin-Dunning-Schumpeter (HODS) approach" in the sense that:

- Countries specialize according to relative factor endowment (this is the Heckscher-Ohlin element);
- Trade specialization changes over time in favour of more technology-intensive goods as cumulated FDI inflows reach a critical threshold. The link between FDI inflows and technology-orientation in production reflect the fact that a natural basis for FDI outflows are ownership specific – often technological – advantages of a multinational firm (this is the Dunning element);
- Firms and countries, respectively, will start to gradually shift towards expanding technology-intensive production and thus record improved export unit values if both foreign direct investment inflows and rising R&D expenditures coincide (Schumpeter perspective).

As ICT goods typically are knowledge-intensive and technology-intensive, we may assume that cost-sensitive elements of ICT production will shift from western Europe to eastern Europe in the medium term, in particular to those countries which are catching up in terms of human capital formation and public support for R&D. In a more general sense we may anticipate further FDI flows – in the manufacturing sector – from EU15 countries to eastern European accession countries. To the extent that services are complementary to manufacturing output and that service provision requires geographical proximity, we may also anticipate a medium term expansion of services FDI in eastern European accession countries. From a EU25 perspective, this type of dynamic structural adjustment should not be perceived as a problem, rather it is an element of a competitive dynamic single EU25 market.

3.2 Management Theories

3.2.1 Internationalisation of Companies

Several approaches for internationalisation strategies of companies are described in the management-literature. This view offers a glance at the strategic inner life of globalizing companies. Entrepreneurship theories differ from most economic theories in that they do not assume coordinated behaviour between companies, but accept that different strategies are sustainable and lead to profitability. The most important theories are based on Meckl/Schramm (2005):

- Monopolistic advantage theory: The multinational company has an unique advantage over other companies used for expansion.
- Oligopolistic reaction theory: Oligopolistic market internationalisation strategies are inherent when the companies follow a forerunner.
- Product life cycle theory: Companies export products to preserve sales opportunities if they are considered mature (Vernon (1966)).
- Step model of the internationalisation process is dedicated to learning processes in organizations (Johanson/Vahlne (1977)). It stresses the risk aspects in foreign markets (e.g., moral hazard risks) which can be met by knowledge. Hence, a gradual entry into foreign markets takes place. Criticism is directed at three points. First, companies with huge resources can act more aggressively and may omit some steps, because the country specific risk is relatively smaller. Second, experiences with foreign markets can also be collected by other means. Third, with similar markets, an ad hoc entry may be rationale if market entry into one segment was successful.
- Theory of internalization: Based on Coase (1937), this theory investigates different entry strategies like acquisition, joint venture or cooperation. In the internalization model, the entry mode choices describe the magnitude of control of the management. A franchise model has a low entry mode, an acquisition with entire integration of the management means having a high entry mode. Risk adjustment in the internalization model is achieved through the choice of the entry mode. This is in contrast to the step model of internationalisation, according to which the quantity and speed at which resources are made available determines the risk exposure.
- Network approach: The internationalisation strategy of a company depends above all on its network, which represents business potential. Market knowledge can be acquired not only within a company, but also by access to a network. Building networks, however, may be less efficient than internalization.

- New venture theory: The new venture theory offers an explanation for accelerating internationalisation, while the importance of knowledge intensity is stressed. Quick and comprehensive market entry takes place to achieve and maintain knowledge advantages.

Looking at management processes, internationalisation cannot be described through merely one, comprehensive approach. Spontaneous decisions by managers reacting to business opportunities often play a big role, and management decisions are always heterogeneous. Lacity/Willcocks (2000) mention that this might be particularly true for the IT sector:

- IT is not a homogenous function. Some IT applications uniquely enable business operations and management processes. Others are less critical and favor the cross-functional integration of business processes.
- The pace of IT capabilities develops rapidly. Needs past a three-year horizon cannot be properly predicted. This is also true for the economics of IT activity.
- For economic efficiency, IT practice may be more important than economies of scale.
- Large switching costs occur.

3.2.2 IT-Outsourcing and Offshoring

This section describes the determinants of outsourcing and offshoring of IT services, mainly from the perspective of the business management literature. In the following sections, this perspective is modified and IT-administration rights as a theoretical concept are introduced, allowing for a linkage of the factor endowment of an economy with IT systems architectures.

IT-Outsourcing can be defined as “obtaining information system services through external organizations which own some or all the necessary resources and where control and management of the resources and activities reside” (Jayatilaka (2002)). An overview of related definitions is given by Goles/Chin (2002).

Meyer/Weinert (2005) give an overview of the development of IT Outsourcing. In the early days the focus was on cost reduction primarily. The idea of strategic outsourcing followed, arguing that managers should concentrate their resources on the company’s core competencies only. Outsourcing nowadays is employed to redesign complete business processes (BPO – Business Process Outsourcing) and increase value across the whole value-chain. This reflects the fact that IT itself is regarded as a key enabler of the process-based organization (Lacity/Willcocks (2000)) and is managed as a strategic driver generating long-term benefits and creating sustainable competitive advantage (Zhu et al. (2001)). The term transformation outsourcing also describes organizational changes, but its concept is much more radical since it totally reshapes organizational boundaries, implying fundamental strategic and structural changes (Linder (2004)). Finally, comprehensive or total outsourcing characterizes the outsourcing of the whole IT system. Lacity/Willcocks (2000) recommend selective outsourcing because “some activities can be outsourced while many others require management’s attention, protection, and nurturing to ensure current and future business success.”

Regarding future developments Carr (2005) predicts the most radical change in the IT sector. He compares IT with electricity and argues that electricity is not produced in a company today but in central power plants. He expects the same development to happen in the IT sector, because fragmentation is wasteful and capital utilization rates are low. In like manner, Allweyer et al. (2004) argue that the ubiquity of IT reduces its strategic significance. Obviously Bhagwati (1985) was correct with his lucent prediction that technological progress would lead to a splintering process which separates services from goods.

According to Lacity/Willcocks (2000), Quinn (2000), Allweyer et. al. (2004), Erber/Sayed-Ahmed (2005), Rubalcaba-Bermejo (2004), Ang/Straub (2002), Meyer/Weinert (2005) and Dibbern/Heinzl (2002), the reasons for IT-outsourcing are:

- Reduction of costs, especially in small projects. A rule of thumb says that above 300 users, a firm should use an ERP (Enterprise Resource Planning) system so that an in-house solution be economically advantageous (Allweyer et al. (2004)). The decision to outsource is based on comparative costs (production economics).
- Using outsourcing as a strategic tool to complement missing internal capabilities.
- Exploiting full business potentials of new technologies in order to gain access to new knowledge and innovations and to improve existing IT systems.
- Outsourcing as a "technical catalyst" for focusing organizational direction, also achieving partial or complete business transformation.
- Shortening the value chain, which diminishes risks (e.g., new provider is responsible for offline times; also defined in Service Level Agreements).
- Leading to more flexibility instead of being captured by long term labour contracts.
- Saving liquidity by lowering investment costs.

On the other hand, the risks of IT-offshoring and outsourcing include (in addition to the authors mentioned above, see also Aubert et al. (2002), who give a short overview on IT outsourcing risks, and Kern/Willcocks (2002), who mention specific risks during contract building):

- Unexpected high transaction costs for searching, creating, negotiating, monitoring, and enforcing a service contract between buyers and suppliers. This might be especially true of offshore outsourcing. For example, Erber/Sayed-Ahmed (2005) calculate that hidden costs may amount to between 15% (best case) and 57% (worst case) of the original international outsourcing contract.
- Political risks, an insufficient enforceability of property rights, the risk of industrial espionage, language barriers and different cultures of human resources management may cause trouble. An additional problem may be internal problems of balancing power.
- Outsourcing brings about a loss of control and loss of know-how as well as dependency on an IT service company.
- Emergence of information asymmetries with the service company. This may be related to quality; additional and hidden costs; vendor selection; the manage-

ment of the organizational interfaces, layoffs and retentions; and management of the IT-contract.

- High switching costs means that the company may to some extent be locked in by an offshore relationship.
- Organizational issues matter. Short term outsourcing decisions (maybe due to lack of capital) may lead to specific problems later. Also, it is difficult to isolate IT easily, because many IT functions penetrate across business functions. Finally, opposition on the part of the domestic workforce can lead to lower productivity despite outsourcing.
- Queries on critical business operations are more difficult. In a survey of Danish companies, Henten/Vad (2002) ascertain that 79% confirm that the delivery of their services requires physical meetings between producers and buyers.

The different reasons for outsourcing mentioned in literature can be assigned to management, economic and social theories. A modified version of the classification of Lee et al. (2002) is shown in Table 4 below.

The resource based theory implies that outsourcing is used to fill the gap between desired and actual capabilities of the company. Deficits in internal resources, knowledge or abilities are covered by outsourcing. The resource dependence theories in contrast focus on the long-run relationships to external companies. Comparative costs theories explain outsourcing through differences in labour, capital and knowledge costs or productivity. The transaction costs theory also takes into account the additional costs for searching, creating, negotiating, monitoring and enforcing a service contract. Dibbern/Heinzl (2002) deduce from the transaction cost theory that the higher the degree of human asset specificity of an information systems function is and the higher the degree of environmental and behavioral uncertainty is, the less likely an outsourcing solution becomes. This may also be true when the number of suppliers is small or the frequency of contracting is high. Agency-Cost theories are related to transaction costs theories but focus on the acting managers in the scope of the principal-agent-approach. Theories which emphasize technological change focus on the costs and possibilities to build up a network. Finally, the social view is related to the resource dependence theories, asking for the distribution of power or emphasizing the advantages of partnership (social exchange). The power theory also takes into account the internal power of the IT department which might try to prevent outsourcing. Klein (2002) reviews a sample of the theoretical literature on outsourcing and finds that the transaction costs theory dominates.

Table 4. Overview on Outsourcing Theories

Orientation	Theory	Focus	Resource	Main constructs
Strategic Management View	Resource based	Internal slack resource	Physical capital, human capital, org. capital	1. Value 2. Rareness 3. Imperfect immutability 4. Nonsubstitutability
.	Resource dependence	External resource (uncertainty)	Land, labour, capital, information, products (service)	1. Task dimensions (concentration, munificence, interconnectedness) 2. Resource dimensions (importance, discretion, alternatives, international availability) 3. Innovation
Economic view	Comparative costs	Cost-efficiency (also economies of scale)	Production cost	1. Production function a) Inputs: labour, capital, knowledge b) Productivity: Efficiency and organization
	Transaction costs	Cost-efficiency despite additional costs	Searching, negotiating, production, monitoring, delivery costs	1. Asset specificity 2. Uncertainty 3. Infrequency 4. Distance 5. Communication costs
	Agency cost	Principal-agent relationship (contracts)	Monitoring costs, bonding cost, residual loss cost	1. Uncertainty 2. Risk aversion 3. Programmability 4. Measurability 5. Length of relationship
	Technological change	Data / information exchange	Communication costs	1. Worldwide IP-network / connectivity 2. Marginal costs of communication
Social view	Power political	Internal power-structure relationship	Power, politic	1. Power (Authority, resource acquisition, dependency and low substitutability, uncertainty absorption) 2. Politic (Selective use of decision criteria, selective use of information, use of outside experts, building coalitions, cooptation)
	Social exchange	Interaction processes	Trust, culture	1. Comparison level 2. Comparison level for alternatives

Source: Lee et. al. (2002), modified and expanded by author

3.3 Macroeconomic Theories on Internationalisation

Macroeconomic theory offers insights into the basic driving forces of economies and thus into the general conditions upon which internationalisation decisions should be based. Traditional macroeconomic theories describe the focus of internationalisation patterns on trade or on foreign direct investment (FDI):

- Trading or purchasing at spot markets. In economic theory the most important approaches are the model by Ricardo, explaining trade by comparative advantages due to different production functions, and the model by Heckscher and Ohlin, which explains trade by different factor endowments of the countries considered. According to the management literature, this implies that no or merely low integration of in-house processes with international partners is necessary. Newer models modify the assumption of homogenous goods and also allow for knowledge-spillovers. A detailed overview of the most important trade theories is given by Feenstra (2004). In a digital economy, the importance of knowledge rises, because its international diffusion occurs more easily. So the high wage countries have to improve products "climbing up the technological ladder" to earn higher returns as observed by Schumpeter (Welfens (2004)). A special case of "traditional trading" is the import of services or intermediate goods called international outsourcing or offshoring. Incorporating this case in theory has led to theoretical models of fragmentation (see below). From the balance of payments view it should be added that trade of services also includes the scenario that the customer moves to the service supplier (e.g., tourism – known as GATS mode 2) and the scenario that an employee of the service supplier is sent to the foreign country (part of GATS mode 4) (UN (2002) – see also Appendix A). Finally from the perspective of management literature, the purchase of services from other companies means that the harmonization of business processes in both companies may become necessary.
- Foreign direct investment (FDI)
  - Greenfield investment (i.e., establishing a new plant in a foreign country). For an in-depth analysis of its determinants see, for example, Dunning (1992).
  - Vertical integration (i.e., the acquisition of suppliers along the value chain). See Markusen (2002) for a comprehensive economic theory on this topic.
  - Horizontal integration, or the merger of companies on the same position of the value chain. The emergence of multinational companies from a macroeconomic perspective is explained by Helpman/Krugman (1985).

Regarding services, FDI corresponds to that of GATS mode 3, with services being carried out by a local affiliate of the service supplier.

Migration describes cross-border labour mobility. Part of past immigration from Eastern European countries has become EU-internal mobility through 2004 enlargement (EU (2005)). Migration is covered by GATS mode 4. See Appendix A for an overview about the GATS modes as well.

Taking into account the factor endowments trade and FDI, both imply an international division of labour. Which pattern of specialisation (if any) is chosen, depends on the goods, production and market characteristics, as well as on the relative factor endowments[4].

3.3.1 Theory of Fragmentation

While traditional macroeconomic theories of trade focus on final goods only, a new strand of literature, the theory on fragmentation, also considers trade in intermediates. This may be particularly important for considering service-orientated economies.

The term 'fragmentation' refers to the decomposition of the production process on different locations. For instance, preproducts and intermediates are purchased to be assembled into a final product domestically. In the business management and economic literature, this and related phenomena are also treated under the terms outsourcing, "delocalization," intra product specialization, intermediate good trade, vertical specialization, and splitting up of the value added chain or "production sharing" (Feenstra (2004)). The EU (2005) uses the concept "relocation," which refers to "the shifting of economic activities to overseas sites." From an economic point of view, it is irrelevant if the intermediates are traded within a multinational company (MNC) or between independent companies. Because of the focus on intermediates, the fragmentation theory also addresses:

- intra-product trade: Trade along the production chain is analyzed and modifies the predictions of traditional trade theory.
- scale effects at pre-product or intermediate level: While scale effects are traditionally considered with the production of final products, the fragmentation theory allows scale effects at the pre-product or intermediates level to also be taken into account. The higher the scale advantages are, a oligopolization or monopolization of this market segment can be expected. Therefore the exploitation of scale effects on the one hand and the existence of several variants of a final product on the other is no contradiction within the scope of the fragmentation theory. To exploit economies of scale, it is also no longer necessary to organize complete production chains within a company. Intermediate and final goods producers can both profit from economies of scale within the value chain. (Arndt/Kierzkowski (2001)).
- factor income: The effects on labour and capital income from entering into worldwide trade become more unequivocal by fragmentation. In particular the employees in a country which shifts the production of labour-intensive preproducts to other countries must not necessarily accept real wage losses. Depending on the competitive intensity and the factor endowments of the countries, constellations with a high-wage and a low-wage country can also be sustainable in the long run (Jones/Kierzkowski (2001)). For an overview on empirical studies about the effects of trade on labour markets, see EU (2005).

[4] Based on US data, Zimny & Mallampally (2002) find, for example, that the internationalisation of services as a whole and of a majority of individual service industries takes place more through FDI than through trade.

- importance of communication networks: The IT sectors play an important role in coordinating the cross-border production processes. This aspect is pivotal in the model of Harris (2001), where the volume of international trade in intermediate products grows when the (worldwide) network costs fall.

Theoretical extensions of the fragmentation approach include the trade of company related services such as marketing and design (Yomogida (2004)) or considering the availability of service supplies as endogenous. Ho/Hoon (2003) postulate that outsourcing is promoted by the variety of services in the destination country. Long et al. (2003) argue that when services are not tradable, service-intensive intermediates are produced in the capital intensive country, whereas with a perfect trade-liberalisation of services the production of intermediates would take place in the labour-intensive country.

3.3.2 The FEENSTRA-HANSON Model

As regards the international outsourcing of services, it is useful to distinguish between standardized and differentiated services:

- services which can be outsourced to countries which have a relatively abundant supply of unskilled labour – e.g. the case of call service centers.
- sophisticated knowledge-intensive services which from a world economy perspective require skilled labour intensively. The latter is the implicit starting point of the model of outsourcing proposed by Feenstra/Hanson (1996; 1997), which may be particularly useful in explaining international outsourcing of services (and of technology-intensive goods).

Feenstra and Hanson assume a continuum of inputs and that the production of final goods is costless. Denoting all production activities required to produce the final good with Z in the interval [0,1], one may classify all activities accordingly in an ascending order with respect to the required ratio of skilled/unskilled labour (e.g., the top being marked by R&D activities), with x(Z) denoting the quantity produced of each of these inputs, a'(Z) the required skilled labour input, a" the required unskilled labour input for one unit of x. In a two country model the dual unit-cost function for producing intermediate inputs can be written as c(W,W',r,Z) where c(…) represents the cost function of producing one unit of x(Z) – given factor prices W,W' and the rental rate of capital r. The share of labour in the costs of producing each input is denoted by θ.

(1) $c(W,W', r,Z) = B[Wa(z) + W'a'(z)]^{\theta} r^{1-\theta}$

Thus the production function of the final good (lnY) is given by the integral over the relevant range 0-1:

(2) $\int a(Z)\ln x(Z)dx = \ln Y$

Here we have – for the integral in the range 0,1 – obviously $\int a(Z)dZ = 1$. Now let us assume that the home country I is relatively skilled labour abundant. As a consequence, the relative wage of skilled labour is lower in country I than in country II (foreign variables will carry *). Moreover, it is assumed that the rental rate of capital in country II (say EU accession countries or Asian NICs) is higher than in country I – say Western Europe. The equilibrium outsourcing solution is then given by the intersection of the initial CD line in Fig. 11, indicating the intermediate product costs for country I, with the initial C*D* line for country II. The initial equilibrium is point E which indicates the split between production in country I and in country II: The initial splitting point indicating efficient fragmentation is Z^*_0. One can calculate the relative demand functions (technically this is a ratio of two integrals) for the skilled/unskilled labour in countries I and II where the integration in the home country is done over the range 0, Z* while in country II the integration is done over the range Z*, 1.

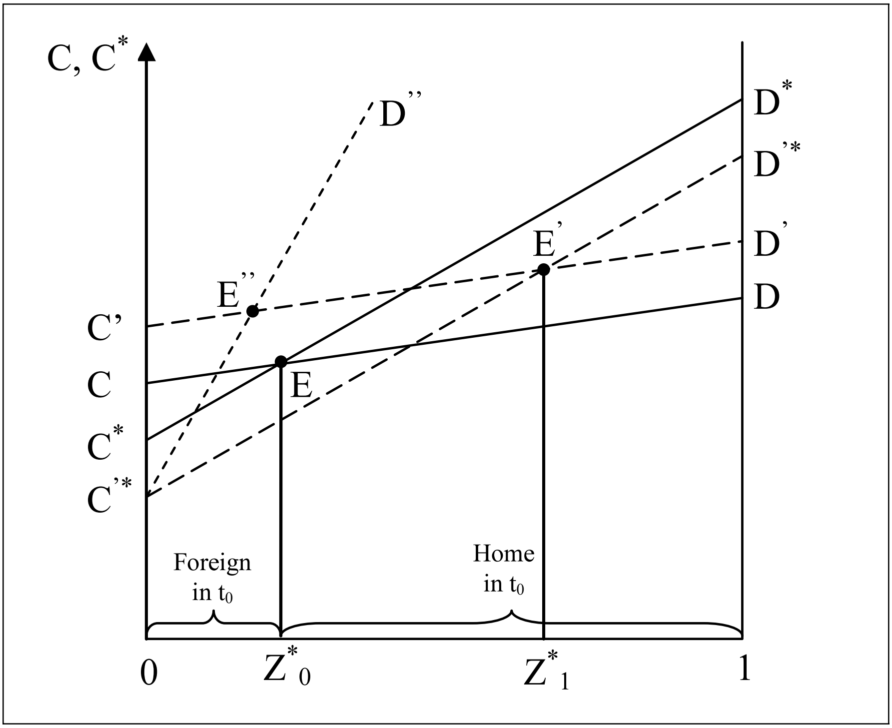


Fig. 11. International Outsourcing in the FEENSTRA-HANSON Model and Capital Mobility

Next we turn to capital mobility. What happens if we introduce capital mobility? Capital will flow from country I to country II, which entails a shift in the costs curves to C'D' in country I and C'*D'* in country II. The new intersection point E' indicates now that a higher share of value added has been achieved in country II. An important implication is that the relative demand for skilled labour rises in both countries so that unskilled labour could be the loser of free capital movements. As regards EU eastern enlargement, we may anticipate from this model in particular the relocation production of ICT intermediate goods to EU accession countries – and from there later to Asian NICs. Moreover, we can explain some of the international services outsourcing observed in the EU. However, we can also anticipate an insourcing effect in leading EU services economies if the productivity of the respective services firm is raised through quality upgrading of capital and computer investment/ICT accumulation. This effect – not contained in the original Feenstra-Hanson model – will raise relative productivity of skilled labour (the C'D' curve will become steeper, and an upward rotation can shift the new intersection point with C'*D'* even to the left of the Z^*_0 point); some of these effects may even occur through positive cross-sectoral spillover effects, and those can be expected to be stronger in leading OECD countries than in catching-up countries. Spillover effects in an economy with digital networks could indeed play an important role in the age of the Digital Economy.

Thus we find the Feenstra-Hanson model quite useful. This holds in particular since multinational companies have been major driving forces in EU eastern enlargement on the one hand and in the ICT sector dynamics worldwide on the other.

3.3.3 Basic Theory of Outsourcing and of Asset-Seeking FDI

A useful model of the outsourcing decision is Grossman/Helpman (2002), which argues that firms consider the alternative of producing in a vertically integrated manner or outsourcing production of certain components. Final goods producers therefore engage in a searching process for subcontractors which involves incomplete information problems, as potential supplier firms find it difficult to signal their respective quality. The approach of Grossman/Helpman explains outsourcing partly through bargaining power, the degree of competition in the relevant market and the number of potential partners in the market. This suggests that the benefits from outsourcing will differ across sectors, firms and plants.

Services markets are rather heterogeneous, and information markets in fact largely represent markets with differentiated products in a context of network effects which can generate considerable international differences in terms of profitability. Such a setting stimulates foreign direct investment. If FDI occurs within the OECD countries, one may – as is emphasized subsequently – not only anticipate the standard effects such as a rise in the profit rate for the investors of the host country of FDI and a rise in real wages in the host country. Rather, the dynamics can be more complex, and initial FDI abroad could translate into an international technology transfer back to the headquarters or the country in which the parent company is located.

A closer look at Fig. 12 which is a slightly modified McDougall diagram is useful. FDI asset-seeking investment can be easily analyzed in terms of the McDougall diagram, which portrays – for a given world endowment with capital (two country approach; country II, the foreign country, has starred variables) – the marginal product schedule Y_K in the home country and the foreign country (Y^*_K). The initial allocation of capital in the world economy is assumed to be characterized by K_o, K^*_o. Firms are assumed to be profit-maximizing so that the marginal product of capital will be equal to the real interest rate r. The standard approach suggests that after economic opening up the intersection (E_o) of the Y_{Ko} curve and the Y_{Ko}* curve will characterize international equilibrium. Country I will employ K_1 instead of K_o so that corresponding capital inflows exist. As the area below the marginal product curve is equal to output, the welfare gain for the capital importing country is the triangle DE_oG; for the capital exporting country, it is GE_oF. If the investing firms from country II enjoy international spillover effects or can upgrade technological knowledge in country I and transfer part of this back to the respective parent companies, the marginal product schedule Y_K* will shift upwards. The new long run equilibrium allocation is K_2, K^*_2 which implies that FDI flows could reduce after an initial liberalization period with rising FDI flows. There is an additional positive global welfare effect equivalent to the area $A^*E_oE_1B^*$. Such asset-seeking foreign investment could be particularly relevant in the services sector, and even more generally in the nontradables sector. In the tradables sector, one may assume that due to trade there are always prospects for international learning and hence positive international spillover effects. However, taking a closer look at hotel services or banking services or computer services that without foreign direct investment international technology transfer is quite difficult. For dynamic firms in an open economy, it thus makes sense to invest in a leading OECD country in order to pick up some of the new technologies through provision of services in those foreign markets. ICT could be quite useful in accelerating the learning process and minimizing international knowledge transfer costs within the firm. International technology sourcing and technology transfer could become more simple through ICT.

In a model with trade and FDI, there would be an additional dimension where one would have to consider the alternatives FDI/trade as substitutes or complements.

As regards outsourcing dynamics one also has to consider the mix of fixed management costs and other costs in combination with the degree of standardization. Following Antras/Helpman (2004), international out-sourcing is positively influenced by the degree of standardization. Outsourcing is characterized by stages:

- first outsourcing will go to domestic affiliates and then
- with rising standardization, outsourcing goes to foreign affiliates (captive international outsourcing);
- further standardization should bring more domestic outsourcing to non-affiliated companies;
- with full standardization there will be growing international outsourcing to non-affiliated companies.

This suggests a sequence of outsourcing patterns, and the degree of standardization plays a crucial role (see appendix A). Standardization in turn is affected by the expansion of ICT.

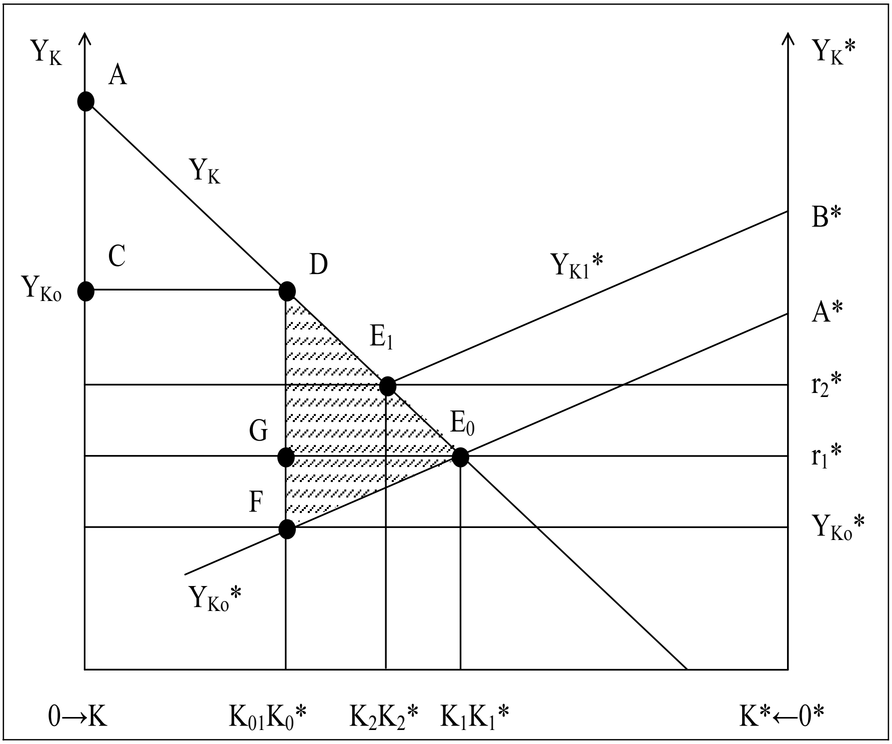


Fig. 12. FDI Flows and International Technology Spillovers

4 Conclusions

4.1 Perspectives on ICT Market Dynamics

Internationalisation in ICT sectors will not be homogeneous. It will differ in particular with respect to the type of goods and services involved. Traditional Fordist sectors can be expected to be subject to strong globalization pressure with trade dynamics being strong. Schumpeterian Fordist sectors which are knowledge-intensive and represent high economies of scale should be shaped by trade, foreign direct investment and international alliances. Innovative niche sectors are expected to be subject to product cycle trade so that both trade and FDI should play a role. Traditional niche sectors will be less internationalized than other ICT sectors. As ICT stimulates not only the internationalisation of the ICT sector but also more generally internationalisation across all sectors, economic globalization will accelerate. From this perspective, the transport sector will benefit, and RCAs in transport services sector will become highly relevant in economic terms (see Appendix A which shows selected indicators), at least for ICT goods. As regards ICT services the modernization and expansion of digital networks is more relevant for both internationalisation and innovation (Welfens/Weske, 2006).

Firms which compete in dynamic large home markets can be expected to generate those competitive advantages crucial for achieving global leadership. With EU eastern enlargement, EU firms could benefit from a larger home market in many ICT sub-sectors. This is even more than case if market segmentations in many government-shaped sectors (e.g., health, education, defence) could be overcome. In the field of telecommunications services, one might in the long run anticipate even true global markets which raise the issue as to whether EU regulation and national regulation sufficiently allows innovative telecommunication firms to earn Schumpeterian economic rents in home markets. Without adequate Schumpeterian profits, achieving global leadership in Schumpeterian Fordist sectors is unlikely since the presence of both economies of scale and high knowledge intensity implies that there will be imperfect competition in global markets.

There is ongoing pressure on the internationalisation of services, as global digital networks are growing and since there are large international wage differences. On the other hand, computer experts and software engineers are leading the wage ladder in advanced OECD countries – for the case of the US, see Appendix A. Hence simple standardized programming will be outsourced, typically to low wage countries with adequately skilled labour. As much as international outsourcing might be worrisome, one should be aware that economic globalization will bring about insourcing opportunities for EU countries. Outsourcing and offshoring can generate economic benefits in a standard two-country model, namely for both countries concerned. However, one should not overlook the problem that offshoring could become a problem for EU countries if the offshoring process goes along with accelerated international technology transfer to non-EU countries and if a rising share of R&D is undertaken abroad.

In the context of R&D activities, one should also take a critical look at EU inward foreign direct investment:

- Inward FDI could imply international relocation of crucial R&D activities. If Asian telecommunications equipment manufacturers acquire companies in the EU, for example, there is considerable risk that some of the R&D activities in the EU will be closed down or shifted towards Asia or the company headquarters region. This is not only a negative impulse for innovation dynamics in the respective EU sector, rather there will also be negative indirect effects, namely reduced cross-sectoral spillover effects.
- If the EU represents only part of the value-added chain in the ICT sector, the desire of major host countries to attract high FDI inflows could be to the disadvantage of the EU. For instance, if China liberalises the tele-communications market it might be willing to accept FDI in tele-communications network operation only if the respective source country of FDI is also willing to stimulate FDI in downstream or upstream activities. This type of politico-economic package dealing seems to be becoming important in Asia at the beginning of the 21st century. If governments in EU countries conduct policy in a traditional style, EU firms interested in international outsourcing or offshoring might have a disadvantage vis-à-vis US competitors, for whom occasionally broad coop-

eration between industry and the federal government helps to bring about FDI package deals. As there is no EU federal government smooth cooperation between the EU; the Commission and the EU business community is required. In any case achieving a level EU playing field is often more difficult to organize than in the US. It is unclear whether the European Commission and the member states can organize the required broad cooperation across political layers and across many firms in the EU.

While international outsourcing and offshoring became a rather common phenomenon in manufacturing industry in the 1990s and the early 21st century, the services sector is still relatively underinternationalised. The internationalisation of services and of service outsourcing is rather underdeveloped (at least in comparison to the manufacturing sector), and several reasons can be mention, with some special caveats in the field of ICT:

- International outsourcing will contribute to an increased wage share of skilled labour, ceteris paribus. As ICT technologies facilitate international outsourcing, one may anticipate that skilled workers will receive strong benefits from ICT expansion. Moreover, it is important that governments in EU countries and the European Commission encourage retraining and human capital formation. As regards unskilled workers, one may have to face a rather strong fall of unskilled worker wages unless the economy records high sustained growth; with full employment being approached, there will be an increasing demand for unskilled workers simply because there will be many households with skilled workers who are likely to demand services done by unskilled workers. (By and large, this was the full employment story of the US in the late 1990s.)
- Rising computer investment in overall investment can be expected to raise the share of skilled wages in the overall wage bill. With computer prices continuing to fall, there will be a rising ratio of computer investment to overall investment in both OECD countries and worldwide. This will reinforce the wage differential between skilled and unskilled workers in the medium term. Only if the share of unskilled workers falls through human capital upgrading could one not expect this development. Whether OECD countries – often facing tight budget constraints and a rising burden of social security expenditures in the context of ageing societies – are up to this challenge is a crucial question. Globalization dynamics do not support human capital upgrading endogenously. Rather, the general fall in the tenure of workers in multinational companies as well as the growing role of MNCs in OECD countries lets one expect that the incentive for major firms to investment in human capital upgrading will fall. Governments might consider counterbalancing this development through tax incentives; for instance, there could be two different corporate tax rates, with the lower rate valid only for firms with above-average retraining.
- Service outsourcing is often complementary to the activity of a manufacturing firm and involves to a relatively high extent quality uncertainty.
- In the Irish electronics industry, service outsourcing was found to positively depend on the size of the plant. Outsourcing services often did not contribute towards increased profit rates of the outsourcing firm.

- International outsourcing of services is rather small in countries such as the US and the UK; however, it has been growing in the 1990s. Should the trend continue in the UK – where the growth rate of international service outsourcing is higher than in the field of material inputs –, the import of services will be a major phenomenon.
- The structure of FDI matters for the aggregate services trade balance.
- From an EU perspective, one should not overlook that there is considerable insourcing in the sense that firms in the US, for example, outsource services to EU countries. Thus, rising international trade in services (in particular in the ICT sector) cannot be considered as a major threat for EU countries.
- As the example of the US software sector has shown, international outsourcing involves mainly standardized services so that the US, as a country richly endowed with skilled labour, can more easily expand in the field of complex software design.

In the ICT sector, there are several special observations relevant for the telecommunications sector:

The internationalisation of ICT will continue as falling intra-firm transaction costs coincide with an increasing R&D intensity within the ICT sector. Governments in EU countries should investment more in R&D support. Given the relative innovation differentials within the EU (Jungmittag, 2004), however, the optimum R&D-GDP ratio will certainly differ across countries. Special projects and programs related to the ICT sector could be useful; this approach is particularly valid if positive external effects from ICT innovation projects are relatively large. Encouraging the networking of SMEs in knowledge-intensive and science intensive sectors could also be a crucial policy element. Given the growth of the global knowledge society, it will also be important for regulatory policy to encourage modernization of telecommunications networks. More labour market flexibility in many countries of the Euro zone might also be a requirement to fully exploit the benefits of the digital economy.

Growing internationalisation of the ICT sector (including outsourcing) is a natural element of structural change and economic growth. There is hardly any reason to ring the alarm bell about the hollowing out of German (or EU15) industry; indeed, there is no simple bazaar effect which would be dangerous for economic development and employment. There are imported intermediate products in export goods, but there are also exported intermediate products in import goods (Welfens/Borbèly, 2005).

As regards Eastern European accession countries, it would be desirable for national governments and collective bargaining actors to find ways to reduce unemployment rates. At the same time, governments would be wise to stimulate both economic modernization and innovation. This should include adequate incentives not only for FDI inflows but also for developing multinational companies, which are able to actively use foreign sources of innovation and knowledge abroad. EU structural policies should take some of these aspects into consideration in the future.

Comparing the Eurozone to the US (or ASEAN countries), there might be problems of optimum outsourcing, as the resistance of trade unions in countries with high unemployment rates will impair outsourcing which reduces profitability and hence the ability to finance innovation and international marketing campaigns. At the same time, one should emphasize that for high wage EU15 countries it will naturally become important in the medium term to specialize more on services which are less exposed to price competition. However, such specialization will require not only flexible outsourcing but also higher expenditures on education in order to have a well-educated workforce. Here the problems of the ageing societies will impair a rise in the public education budget. Ageing societies in Europe might have a priority for spending more taxpayers' money on social security, in particular retirement benefits. Globalization at the same time means that the average tenure of workers as well as the incentive for firms to invest in human capital upgrading is declining. Thus, the EU is facing serious risks of losing (relative to the US) two traditional advantages relevant for productivity and growth.

4.2 Dynamics of Internationalisation

ICT is not a homogenous sector, and internationalisation dynamics are expected to differ across sectors. Globalization in the sense of international outsourcing and offshoring could be relatively fast in sectors with high economies of scale and low knowledge intensity. In sectors with high economies of scale and high knowledge intensity, one may expect from an EU15 perspective that outsourcing of intermediate products (in many cases, this also means offshoring) to some accession countries – with a relatively high endowment of skilled labor and adequate locational advantages in terms of availability of human capital and R&D facilities – will take place and gather momentum over time. As ICT expansion in accession countries contributes to higher productivity and output growth, the implied increase in the EU25 market will make the Community more attractive to foreign investors. Eastern European countries with successful specialization in ICT will also certainly offer attractive perspectives for indigenous start-up firms in ICT.

The expansion of ICT will not only have an impact upon the internationalization of the ICT sector, but it will contribute to the internationalisation of the overall economy: The expansion of Fordist production is thus expected; the role of economies of scale will be more important in the production of intermediate products than in the production of final goods. In economies where consumers have higher per capita income, the demand for differentiated products will increase. As regards digital services, the internet has created truly global markets; one may anticipate that in global markets for standardized digital products, only a few big firms can survive. This indeed might be true in the field of telecommunications network operation and digital services. However, one should not overlook the fact that in the field of digital services, the user will often require customer-tailored IT solutions which require high knowledge-intensity in the provision of services. ICT services thus could indeed represent a split development. While software to some extent will become a global market, IT services in certain fields might remain nationally fragmented; this is the case in such fields as health care or education where governments are major customers and where willingness to cooperate at the national or international level apparently is rather limited. Here one might have a field in which the European Commission might want to encourage regional cooperation in border regions in order to encourage creation of joint services providers in the Community.

There is no general trend towards more international outsourcing and offshoring. Rather, there will be outsourcing/offshoring and insourcing/inshoring at the same time. In fields which are rather knowledge-intensive and hardly show economies of scale, many EU countries may be expected to be rather well positioned and to mainly face stiff competition from the US. Quality competition will be the main characteristic in these sectors. However, fields with considerable scale economies and low knowledge-intensity are more likely to be exposed to global competition; high wage EU countries clearly have a disadvantage in this field. Basically, the single EU market is large enough to exploit considerable scale economies in the home market so that even in electronics, some EU countries should be well positioned to play a role at least in high-end products and in the first stage of the product cycle. One should note that it is an open question whether institutions – ranging from innovation systems to labor market institutions – are flexible and advanced enough in EU countries to make the Community a fertile breeding ground for the expansion of the ICT sector. The expansion of ICT will raise many new challenges; at the same time it creates many new opportunities – including innovative options for raising productivity in an ageing society. ICT dynamics will differ across sectors and across countries. Only the empirical analysis of RCAs and foreign direct investment patterns can shed more light on the analysis.

Using the goals of the "Lisbon Agenda" as an orientation, the following conclusions can be drawn from the theoretical considerations in the previous sections:

- The IT sector is interwoven with the rest of the economy. One instrument to promote the internationalisation of IT service companies is to also promote the internationalisation of non-ICT companies. Therefore a politically driven internationalisation strategy should always take into account the macroeconomic consequences.
- There is little reason to fear that the IT services of the capital intensive European industries will be outsourced to third countries extensively even though in-house (internal) offshoring in multinational companies may increase.
- On the other hand a strategy should be developed to attract IT business from labour intensive countries, particularly from those countries which export to the EU extensively. This might be a rationale for both sides. Skills in foreign language must be improved (see below).
- One instrument to achieve a high level of competition in the IT sector is to protect the openness of interfaces. An IPTS (2001) report describes the chances, risks of market fragmentation and possibilities to politically support open standards, depending on the stage of market development.
- Innovation is much more important for a digital goods producer than for B2B service companies. Network, scale and lock-in effects favour monopolization. From this point of view, a joint strategy of the EU member states to establish a

public digital trust centre as an infrastructure supplier which would allow new digital applications internationally should be discussed.

- As a general purpose technology, all security issues should be highlighted. Efficiency gains are diminished by the threat of computer viruses, hijacking, spam, and the like. Careful data handling and methods of computer protection should be learnt in school as well as being the individual's responsibility when using data.
- Knowledge matters for all internationalisation strategies. In a study on knowledge-intensive business services in Finland, Toivonen (2002) identifies the fields of expertise that are central in terms of internationalisation:
  - country specific information and knowledge
  - mastery of the routines required by internationalisation (law, legislation)
  - sector specific know-how
  - business skills (especially entrepreneurial skills), customer orientation and marketing
  - expertise in information technology
  - networking skills

These are prerequisites for all expansion strategies of European ICT-companies. Furthermore, Pilat/Devlin (2004) point to a self-enforcing effect. Having a strong ICT sector may help generate the skills needed to benefit from ICT use.

At the bottom line, it is clear that ICT technology facilitates the organization of more complex and flexible multinational companies. Moreover, since ICT is a major driver of innovation, the expansion of ICT reinforces ownership-specific advantages and hence stimulates foreign direct investment. One should also note that a positive link between the size of a market and the optimum plant size implies that regional economic integration reinforces international mergers & acquisitions. As the EU single market programme and EU eastern enlargement both contribute to creating larger markets, one may indeed anticipate an impulse for international M&As in the EU. However, to the extent that governments interfere in capital market dynamics in the form of favouring the creation of national champions over international M&As, the single EU market cannot fully unfold its economic benefits. The EU will never be able to match the economic strength of the US if renewed economic nationalism continues, as this will undermine the prospects of creating European firms in the true sense of the word "European."

CHAPTER III. Empirical Analysis of the Competitive Trade Position

Theo Dunnewijk and Huub Meijers

1 Introduction

This chapter describes the current state and trends of the internationalisation of Information and Communication Technology (ICT) activities in EU25 from a quantitative point of view. In this chapter, internationalisation is defined simply as the quantity of international trade among nations. The focus is on European Union (EU) member states and other countries such as, Korea, Japan, and the US. The aim of this chapter is to reveal the possible drivers behind the trade in ICT goods and services. Although trade with countries such as China and India is taken into account, an explanation of these developments through an investigation of underlying forces is not possible due to severe data limitations. For instance, information on labour productivity and R&D investment per sector are often not available for many non-OECD countries, let alone for a time series analysis. The latter is necessary to depict the dynamics of trade in ICT goods and services.

After a short introduction, the second part of this chapter defines ICT activities and describes both its relative size in total economic activity and its evolution during the period 1993 - 2003. The data used in this section is based on the SITC[1] product classification, which is a derived classification based on economic activities or ISIC[2] activity classification, the latter of which is used in the second part of this chapter. This chapter also provides a detailed insight into EU25 trade of ICT goods and services with the Rest of the World, most notably with China (as an effective price competitor) and Japan (as an effective quality competitor). Volume, price and quality of this trade and its associated contribution to the current account of the trade balance, are highlighted.

The third part of this chapter sheds lights on current trends in the market shares, revealed comparative advantages (RCA's), and value added and quality of labour in the production of the following ICT industries over the 1992-2002 period: manufacturing of computers (ISIC30), radio, TV etc. (ISIC32); medical and optical equipment (ISIC33); communication services (ISIC64); and computer services (ISIC72).

The fourth part provides an overview of some of the other trends by defining the shifts in international trade in ICT products and ICT services, and ends with a common emerging pattern of these developments.

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1 Standard International Trade Classification (SITC)
2 International Standard Industrial Classification of All Economic Activities (ISIC)

Section 5 closes the chapter by summarizing the main conclusions.

2 Size and Developments of European ICT Activities

It is well known that ICT affects productivity and hence economic growth, especially in environments characterised by liberalisation and deregulation. ICT as a general purpose technology also asks for the rethinking of service activities that are already subject to internationalisation such as trade and transport, financial services, and business services industries. The transmission channels between ICT and productivity and growth are expected to include gross fixed capital formation, more and more intense use of knowledge, international trade, and foreign direct investment.

ICT also reduces (intra firm) transaction costs and carries network effects (Meijers, 2004) based on the fact that the use of ICT has become cheaper and cheaper due to the falling costs of telecommunication, a consequence of the liberalisation of telecom markets which is an international phenomenon. The combined and aggregate effect of these developments is an accelerated diffusion of knowledge and increased productivity growth. (Bartelsman & Hinloopen 2001, Meijers, 2004a, Van Ark, 2001, and paragraph 2.1 of this book)

Crucial to these developments is the competitive position of a nation relative to its competitors. Therefore, we consider price and cost factors critical to the competitiveness of the different relevant markets we investigate. Data on ICT are being collected according to two different classifications which are based on either activities or industries. According to the 2-digit *industry* classification, ICT comprises:

- Office, accounting and computing machinery (ISIC 30),
- Radio and television and communication equipment (ISIC 32),
- Medical, precision and optical instruments (ISIC 33),
- Post and Telecommunication (ISIC 64),
- Computer and related services (ISIC 72), and/or
- (Part of) Research and other business services (ISIC 73-74).

Data on trade statistics are defined according to a product rather than an industry classification. ICT *products* can be defined as:

- Office machines and automatic data-processing machines (SITC 75),
- Telecommunication and sound-recording and reproducing apparatus and equipment (SITC 76),
- Electrical machinery, apparatus and appliances and electrical parts thereof (SITC 77),
- Professional, scientific and controlling instruments and apparatus (SITC 87), and/or
- Photographic apparatus, equipment and supplies and optical goods, watches and clocks (SITC 88).

Appendix B provides both a more detailed overview of the SITC product classification, and the relation between products and the producing sectors, without having to define a formal link between the two classifications which is quite obvious at the detailed level.

We depend heavily on the availability and quality of the data, primarily due to the emphasis on quantitative developments in this chapter. Therefore, we are forced into a time frame of 1996-2002 and into the study of a defined number of countries the selection of which is dictated by data availability.

The main data sources we used include: OECD STAN Industry database, the 60 Industry databases of the Groningen Growth Centre, Eurostats COMEXT product database, the Balance of Payments Statistics of the IMF, and several others.[3]

As mentioned above, this section will analyse the trade position of the EU25 with respect to ICT goods and services. It presents an overview of European ICT trade positions with the Rest of the World, most notably with China and Japan. The relative importance of ICT goods as a share of trade, and the volume and price trends are highlighted with special attention paid to price trends in the traded ICT goods and services. It turns out that pure price competition in trade in ICT goods is not really an option for the EU25; therefore, the focus should be on quality competition, a process that has already been initiated.

2.1 A Bird's Eye View of European Trade in Goods and Services

The EU25 is a relatively open economy. Import as well as export of goods and services make-up 35% of GDP, which is more than twice the US score. The trade balance of the EU25 is almost balanced; the surplus is around 1% of GDP as can be concluded from Table 5.

During 1996–2004, the bilateral trade of all goods and services, as a percentage of GDP, of EU25 with the Rest of the World increased substantially. Exports increased from 30% of GDP to 35%, and imports rose from 28% to 35% during 1996–2004. This pattern is extremely common, where international trade expands faster than the national production of nations due to ever-increasing specialisation, liberalisation and internalisation. In 2004, the aggregate exports of goods as a percentage of GDP reached 27% of GDP and trade in services reached 8% of GDP as depicted in Table 5. The trade balance in goods as well as in services shows a slight surplus. The ratio between the price of exports and the unit value of imports[4] is commonly referred to as the 'terms of trade', which in this case, fluctuated around 3.4 during 1996–2004, indicating that exports outweighed imports as far as prices per unit were concerned. However, the terms of trade of aggregate goods deteriorated from 3.7 in 1995 to 3.1 in 2000, meaning that export prices per unit declined by 4.5% annually relative to import prices per unit. While the EU25 terms of trade improved steadily after 2000, they were not able to regain the 1995 level.

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[3] See Appendix B for more details.

[4] The price of exports and imports are the ratios between the value and the quantity, values in euros and quantities in kilograms.

Table 5. EU25's GDP and Trade in Goods and Services, Total Economy

EU-25	1996	1997	1998	1999	2000	2001	2002	2003	2004
billion euros									
gross domestic product (market prices)	7314	7713	8077	8485	9090	9451	9799	9939	10409
exports of goods	1725	1932	2033	2128	2533	2630	2650	2632	2857
idem as % of GDP	*24*	*25*	*25*	*25*	*28*	*28*	*27*	*26*	*27*
export of services	475	539	587	638	750	793	820	822	882
idem as % GDP	*6*	*7*	*7*	*8*	*8*	*8*	*8*	*8*	*8*
import of goods	1622	1816	1947	2081	2540	2580	2554	2558	2812
idem as % of GDP	*22*	*24*	*24*	*25*	*28*	*27*	*26*	*26*	*27*
import of services	456	502	551	607	718	764	763	765	802
idem as % GDP	*6*	*7*	*7*	*7*	*8*	*8*	*8*	*8*	*8*
trade balance goods	104	116	86	46	-7	50	96	74	45
trade balance services	19	37	36	31	33	30	57	58	80
terms of trade goods (=price exports/price import	3.7	3.6	3.5	3.4	3.1	3.6	3.5	3.5	3.5

source: Eurostat

2.2 EU25's Trade in ICT Goods and Services

The EU25 ICT trade with the Rest of the World includes trade in computers (ISIC30), radios and TV's, etc. (ISIC32), medical and optical equipment (ISIC33), communication services (ISIC64), and computer services (ISIC72). Data on research and other business services (ISIC 73-74) is not included. Table 6 provides an overview of the proportions of the trade in relation to ICT production. Value added of EU25 ICT sector in 2004 was more than €300 billion, which is around 3% as a percentage of aggregate GDP of EU25. The trade balance in ICT goods is persistently negative and increasingly positive for ICT services.

EU25's ICT sector significantly improved its terms of trade in contrast with its aggregate terms of trade. The terms of trade of ICT goods improved from 0.7 in 1996 to 1.4 in 2004, which meant that the ratio of the price of exports to the price of imports for ICT goods doubled during 1996-2004. This might have been a bad sign from the perspective of price competition; however, from the perspective of quality competition, it might have been a good sign. The question is whether ICT trade is dominated by price competition or quality competition? Price competition assumes the price of goods and services as the decisive factor for the demand for these products. If this is the case, then increasing terms of trade is a bad sign given that ICT price changes of exports is persistently higher than price changes of imports and as such, EU25 ICT goods market shares are bound to fall in the near future. If on the other hand the market regime is characterised by quality competition, then increasing terms of trade is an encouraging sign. This will be further analysed in the next sections. At this point, we continue with a more detailed and further look into the trends of prices and volumes of trade in ICT goods.

Prices (unit values) of ICT goods are falling relative to aggregate goods as is depicted in Table 7. Price erosion of ICT products is a well known phenomenon and is considered the consequence of the fast succession of different generations of ICT components, especially microprocessors and memories. While the capacity of ICT goods increase due to the fast pace of the technological improvements of the newer generations, prices of the older generations of products fall mostly due to the harsh price-competition found in this market. This has driven down the prices of 'computing power' since the 1960s Gordon (2000), while the use of ICT curbs inflation itself Meijers (2006). Therefore, it is indeed quite remarkable to see that until 2000, unlike its ICT imports, the EU25's ICT exports do not appear to show price erosion. Only after 2000 does the EU25's export prices of ICT goods decline, however not as much as those of imports of ICT goods. The intriguing question is what drives these diverging price developments? Before we answer this question, we must recognise that in general, unit values of ICT products are not highly reliable measures of quality and sophistication, but compared on a sufficient level of desaggregation unit values might indeed be a measure of quality and sophistication, not least due to the relative homogeneity of these goods.

Table 6. EU25's GDP and Trade in (ICT) Goods and Services

EU25	1996	1997	1998	1999	2000	2001	2002	2003	2004
billion euros									
value added ICT sector (market prices)	175	199	224	245	277	285	293	301	310
idem of % of aggregate GDP	*2.4*	*2.6*	*2.8*	*2.9*	*3.1*	*3.0*	*3.0*	*3.0*	*3.0*
exports of ICT goods	92	110	113	125	168	167	155	152	169
idem as % of GDP of ICT sector	*52.4*	*55.3*	*50.3*	*51.1*	*60.5*	*58.5*	*52.9*	*50.4*	*54.7*
exports of ICT services	19	22	26	28	37	44	47	50	56
idem as % of GDP of ICT sector	*10.8*	*11.2*	*11.4*	*11.6*	*13.4*	*15.4*	*15.9*	*16.5*	*18.2*
imports of ICT goods	116	135	151	178	246	228	208	204	225
idem as % of GDP of ICT sector	66.1	68.0	67.1	72.6	88.6	79.7	70.9	67.8	72.6
imports of ICT services	12	16	19	21	26	30	31	31	32
idem as % of GDP of ICT sector	*6.9*	*7.9*	*8.6*	*8.5*	*9.4*	*10.6*	*10.4*	*10.2*	*10.2*
trade balance ICT goods	-24	-25	-38	-53	-78	-61	-53	-52	-55
Trade balance ICT services	7	7	6	7	11	14	16	19	25
ICT goods: terms of trade	0.7	0.7	0.8	0.9	0.9	1.0	1.0	1.0	1.4

sources: Eurostat, Balance of Payment Statistics, IMF

Table 7 describes the trends in volumes and prices (unit values) in the trade of EU25 with the Rest of the World. This table shows that the price of aggregate exports of goods increased (cumulative) by 34% percentage points during 1995-2004 while the price of aggregate imports of goods increased by 43% points. The opposite is true for EU25 trade in ICT. While the unit value of exports was raised by 12% points, the unit value of imports declined by 47%! Assuming competitive markets in ICT goods, this improvement in the terms of trade of ICT goods of EU25 might be an indication that the quality of EU25 ICT goods exports rises faster than the quality of its imports. The price developments imply that the volumes of trade in ICT goods as compared with all goods, are much more abundant: the volume of imported ICT goods doubled during period 1995-2004 while the aggregate imports 'only' increased by 45%.

Table 7. EU25 Trade with Rest of World: Volumes and Unit Values of ICT Goods

Trade of EU25- Rest of the world	1996	1997	1998	1999	2000	2001	2002	2003	2004
	1995=100								
exports of goods									
volume	101	106	104	115	123	118	125	132	138
unit value	107	117	119	115	134	146	138	128	134
imports of goods									
volume	98	101	101	117	125	128	129	136	143
unit value	109	122	127	127	158	153	145	137	143
export of ICT goods									
volume	108	116	119	118	132	143	140	156	184
unit value	103	115	114	129	154	142	134	118	112
import of ICT goods									
volume	111	133	137	152	203	202	188	184	205
unit value	101	105	97	95	115	92	91	79	53

source: Eurostat

More details on these price developments of ICT goods are shown in Table 8**.** Note that when all traded ICT goods are considered together an increasing terms of trade over the period 1996 – 2004 is depicted. In 1996, the unit value of EU25 exports of ICT goods was 30% lower than its imports, however in 2004 the same unit value is 40% higher. Each of the ICT goods follows the same pattern: unit values of EU25's exports decline much more slowly than those of EU25's imports of ICT goods. This is especially the case for office machines and computers (SITC 75), telecom equipment (SITC 76), and photographic apparatus, etc. (SITC 88).

Given these developments, it is not unlikely that the quality of EU25's ICT goods export is increasingly higher than the quality of imported ICT goods from the Rest of the World. This might be true for telecom equipment (SITC 76), electrical machinery (SITC 77), professional instruments (SITC 87), and photographic apparatus (SITC 88), as exhibited in Table 9. In this table the average annual growth of quantities and prices are exhibited over the period 1996-2003. It is obvious that, measured in quantities, the EU25 market is more and more flooded with ICT products from abroad while expansion is much less in products (in quantities) leaving the EU25 for export. That is one side of the coin; the other side is that prices[5] of exports increasingly diverge from the prices of imports. The consequence of this process is that the exported values (exports measured in Euros) of electrical machinery (SITC 77), professional instruments (SITC 87) and photographic apparatus (SITC 88) have faster growth rates than their imported counterparts do. Consequently, behind the persistent negative trade balance of ICT goods is the very different trend towards higher priced exports as compared to all imported ICT goods.

5 Measured here in unit values.

Table 8. EU25's Trade with Rest of World: Unit Values of ICT Goods

EU-25	1996	1997	1998	1999	2000	2001	2002	2003	2004
UNIT VALUES ICT GOODS									
SITC 75-77,87-88									
export of ICT goods	2511	2799	2793	3155	3769	3464	3278	2876	2729
import of ICT goods	3614	3768	3472	3424	4147	3306	3275	2824	1915
terms of trade in ICT goods	*0.7*	*0.7*	*0.8*	*0.9*	*0.9*	*1.0*	*1.0*	*1.0*	*1.4*
SITC 75									
export of computers etc	6950	7342	6150	6099	8164	6358	6773	4876	4617
import of computers etc.	4712	4871	3958	3925	4549	3293	4045	3895	1548
terms of trade SITC 75 goods	*1.5*	*1.5*	*1.6*	*1.6*	*1.8*	*1.9*	*1.7*	*1.3*	*3.0*
SITC 76									
export of telecom equipment	3801	4495	4193	9511	10256	11128	9175	7838	7978
import of telecom equipment	3091	3240	3281	3429	4366	3127	3630	3246	2231
terms of trade in SITC 76 goods	*1.2*	*1.4*	*1.3*	*2.8*	*2.3*	*3.6*	*2.5*	*2.4*	*3.6*
SITC 77									
export of electrical machinery etc.	1535	1673	1702	1775	2118	1959	1811	1648	1533
import of electrical machinery etc.	2665	2765	2590	2508	3263	2744	2241	1829	1670
terms of trade in SITC 77 goods	*0.6*	*0.6*	*0.7*	*0.7*	*0.6*	*0.7*	*0.8*	*0.9*	*0.9*
SITC 87									
export of professional instruments etc.	6924	7635	7469	7554	8807	6934	8682	7862	7823
export of professional instruments etc.	7860	7956	7736	7649	9179	7503	7648	6443	5898
terms of trade in SITC 87 goods	*0.9*	*1.0*	*1.0*	*1.0*	*1.0*	*0.9*	*1.1*	*1.2*	*1.3*
SITC 88									
export of photographic apparatus etc.	2416	2594	2774	2766	3457	3497	3451	3123	3250
import of photographic apparatus etc.	4763	5024	4970	5189	5495	5906	5107	4513	3380
terms of trade in SITC 88 goods	*0.5*	*0.5*	*0.6*	*0.5*	*0.6*	*0.6*	*0.7*	*0.7*	*1.0*

source: Eurostat

Table 9. EU25's Trade in ICT Goods with Rest of World (Average Annual % Change 1996-2003)

		quantities	prices	values
SITC 75	export of computers etc	11.6	-5.1	6.4
SITC 76	export of telecom equipment	-1.0	9.3	8.2
SITC 77	export of electrical machinery etc.	7.5	0.0	7.5
SITC 87	export of professional instruments etc.	8.0	1.5	9.6
SITC 88	export of photographic apparatus etc.	1.6	3.7	5.3
SITC 75	import of computers etc.	21.2	-13.9	7.3
SITC 76	import of telecom equipment	17.1	-4.1	13.0
SITC 77	import of electrical machinery etc.	13.8	-5.8	8.0
SITC 87	export of professional instruments etc.	10.9	-3.6	7.3
SITC 88	import of photographic apparatus etc.	5.6	-4.3	1.3

source : COMEXT database EUROSTAT

2.3 EU25 Trade in ICT Goods: Quality and Price Competition

Diverging unit values might be an indication of diverging quality, however, these developments deserve careful consideration given that aggregate unit value as an indicator of prices of exports, is subject to aggregation problems (Aiginger, 1997, Balk, 1998). When calculating aggregate unit values, possible heterogeneous products are added together with their physical weights as weights (Aiginger, 1997). However, at the disaggregated level as presented here, the products might become more homogeneous making unit values more comparable and more suitable as indicators of quality (Aiginger 2001, Peneder, 2003). Of course, the lower the level of aggregation the less likely it is that heterogeneity is a problem and the more likely it is that unit values reflect true price differences. In this case, unit values might help discover quality and innovation issues given that unit values mirror either average costs or technological superiority provided it is far from unit costs, thereby illustrating EU25's competitiveness with regard to ICT products. Furthermore if we assume that demand for ICT goods is price elastic, which is the case under quite broad circumstances (Aiginger, 1997), then we can distinguish four cases regarding price and quality competition. We base these cases on the partial trade surpluses/deficits of the ICT goods and their value differences.

2.4 EU25 Trade in ICT Goods with the Rest of the World

Figure 13 exhibits the ‘playing field’ of these four types of markets as determined by their volume-value combinations. The phenomenon of extra EU25 trade in ICT goods during 1996-2004 is represented in Figure 13 based on the difference between the prices of exports and imports and their volume differences. Price differences (between unit values) are represented along the horizontal axis and their net exported volume (in millions of kilos), along the vertical axis. The shaded circles indicate a trade surplus of that particular product (indicated by a SITC number) for EU25 in, and the open circles indicate a trade deficit. The size of the circle corresponds with the amount of the trade balance. If all ICT goods were price elastic and homogeneous, then an excess of export price (over the price of import) would correspond with an imported volume excess (over the volume of import). If that assumption holds, then all circles should be located along a diagonal from the southeast quadrants to the northwest quadrant of the figure. At first glare, there does not appear to be many exceptions to this rule of thumb. However, watches and clocks (SITC 885) and cathodes (SITC 776) are quite exceptional given that their large negative and positive price differences do not lead to large volume differences.

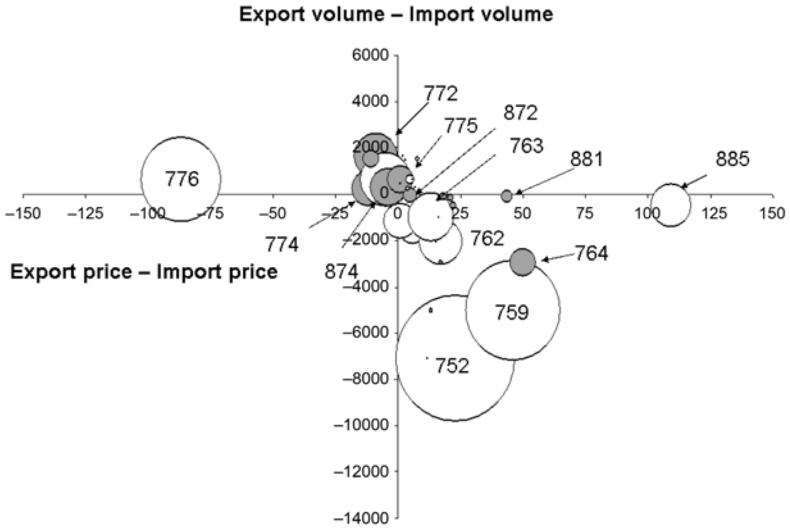


Fig. 13. Assignment of ICT Products in Extra EU25 Trade According to Price and Volume Differences and Contribution to the Trade Balance (Average 1996-2004)

When considering the bilateral trade of EU25 with the Rest of the World in ICT goods, most of these goods are indeed price elastic, i.e. net quantities and net prices have opposite signs[6]. Hence as a general rule, price competition rules, at least under the assumption that these markets are homogeneous. Most of EU25's trade in ICT goods with the Rest of the World as depicted in Figure 13, fall within the category 'priced uncompetitively', and only household type electrical equipment (SITC 775) and cinematographic films, etc. (SITC 883) are products that are characterised by quality competition: these so-called 'quality goods' derive their exported volumes not from their prices but from their quality.

[6] This can be seen in Figure 13 almost all ICT products are located in the north-west and south-east corner in these areas goods are price elastic. Goods that exhibit trade surpluses (exports volume larger than import volumes) have lower prices (compared to their imported counterparts) and the opposite is true for goods that exhibit deficits.

The north-west corner of this figure is the area where *price competition* prevails. In this area volumes of exports are larger than imports (measured by their physical weights), and exports are lower priced than the imports of that specific good. Quite a few ICT products are found[7] in this corner of Figure 13, including electrical apparatus, equipment for distributing electricity, electro diagnostic apparatus and electronic valves (SITC 771-4), thermionic cathodes, etc. (SITC 776), electrical machinery and apparatus (SITC 874), measuring apparatus (SITC 874), and photographic supplies (SITC 882). Their export volumes surpass their imported volumes[8] [9] and at the same time, carry lower prices than their imported counterparts carry. Open circles in Figure 13 indicate a trade balance deficit for that good as is depicted in Table 10. The trade deficit for SITC 776 is more than € 900 million: note that the green bubbles indicate a trade surplus, which is the case for SITC 772, 774, 874 and 882.

That said, most of the traded ICT goods are placed in the southeast area of the figure, where the imported volumes are larger than the exported volumes and the prices of exports are higher than the prices of imports. Products in this area include: computers (SITC 751-2), electronic parts (SITC 759), radio and TV-sets, radio broadcast receivers, sound recorders, producers and telecom equipment (SITC 761-4), optical and medical instruments (SITC 871-2), photographic apparatus, optical goods, and watches and clocks (SITC 881,4,5). Under the assumption of product homogeneity and price elasticity, most of the ICT products are simply too expensive and therefore show larger imports than exports in EU25. Most of these ICT goods are imported very cheaply and in huge amounts as is depicted in Table 11.

A minority of ICT goods are successful in *quality competition* as is seen in the northeast area of Figure 13. In this case, the exported volumes are larger than the imported volumes despite the higher priced exports. Finally, the south-west area of the figure depicts the case in which exported volumes are smaller than imported despite the lower priced exports. Again if these goods are homogeneous, as is assumed, then this situation necessarily implies structural problems for the industry in question. These problems might be related to market conditions or other constraints, such as lack of quality. However, in this collection, the area is empty indicating that this conflict with the assumed homogeneity of the goods is not apparent and as such, there are no ICT goods in this structural problem area.

The average trade balance (between 1996 and 2004) of EU25 with the Rest of the World in ICT products is negative at minus €49 billion. According to Table 6, the deficit is fairly stable over time. Details of this deficit are provided in Table 10 and indicate that there is a €1.3 billion surplus for quality goods (northeast quadrant of figure 13), a €6.270 billion deficit for successful price competition, and minus €43.905 billion resulting from uncompetitive prices. Contrary to what one

[7] Some of these ISIC codes are not mentioned explicitly in Appendix B

[8] By taking the average volumes and unit values over the period 1996-2004 for the trade in ICT goods detailed at the 3-digit level, see Appendix B for more details.

[9] Explanation of these SITC sub groups are given in Appendix B.

would expect, successful price competition does not necessarily imply a positive contribution to the trade balance. Consequently, EU25 produced household electrical equipment (SITC775) and movies (SITC 885) are quality goods. However it should be noted that due to the very small differences in unit values their contribution to the trade balance is only small.

The north-western quadrant of Table 10 depicts the following goods that are attractive due to their price: electric power machinery (SITC 771), electrical apparatus (SITC 772), equipment for distributing electricity (SITC 773), electric diagnostic apparatus (SITC 774), thermionic cold cathodes (SITC 776), other electrical apparatus (SITC 778), measuring and checking instruments (SITC 874), and photographic supplies (SITC 882). However, despite successful price competition, these markets contribute negatively to the trade balance with the Rest of the World with a deficit of €6270 million. SITC 776 is the main cause for this negative contribution.

Twelve products that fall short of price competition are located in the South-eastern quadrant. The products range from computers (SITC 751) to watches (SITC 885). The contribution to the current account is minus € 43.905 billion, which is quite substantial.

Table 10. EU25's Trade with Rest of World: Volume and Unit Values of ICT Goods

EU25 - Rest of World (EU25 EXTRA) trade (averages 1996-2004)

PRICE COMPETITIION: low unit value / quantity surplus

SITC		exports value	exports volume	unit value	import value	import volume	unit value
771	Electric power machinery	3,886.8	3,079,944.1	13	4,109.9	2,639,278.0	16
772	Electrical apparatus	12,100.6	4,059,610.2	30	9,109.6	2,417,395.1	39
773	Equipment for distributing electricity	3,816.2	5,831,116.8	7	3,927.6	4,362,401.6	9
774	Electrodiagnostic apparatus for medical	4,294.0	415,007.3	106	2,376.9	201,660.4	118
776	Thermionic, cold cathode or photo-cathode	16,972.1	8,213,339.7	85	26,724.6	7,593,546.7	172
778	Electrical machinery and apparatus, n.e.s.	9,870.5	2,150,895.8	12	13,765.6	1,535,005.1	17
874	Measuring, checking, analysing and control	14,091.4	1,524,905.0	94	11,807.2	1,226,613.7	98
882	Photographic and cinematographic supplies	2,462.6	2,425,065.0	10	1,943.1	934,253.2	21
8 industries total		*67,494.2*	*27,699,883.9*	*24*	*73764.5*	*20,910,153.8*	*35*
8 industries balance				**-6270**			

QUALITY COMPETITION: high unit value/ quantity surplus

SITC		exports value	exports volume	unit value	imports value	imports volume	unit value
775	Household-type electrical and non-electrical equipment, n.e.s.	5,189.0	8,213,339.7	6	3906.7	7,593,546.7	6
883	Cinematographic film, exposed and	54.7	11,416.3	48	26.8	7,027.3	40
2 industries total		*5243.8*	*8224756.0*	*6*	*3933.5*	*7600574.0*	*5*
2 industries balance				**1310**			

STRUCTURAL PROBLEM AREA: low unit value / quantity deficit

SIITC	exports value	volume	unit value	imports value	volume	unit value

DEFICIT PRICE COMPETITION: high unit value/ quantity deficit

SITC		exports value	exports volume	unit value	imports value	imports volume	unit value
751	Office machines	1,336.9	578,669.3	23	2,341.9	2,114,956.6	18
752	Automatic data-processing machines and units thereof; magnetic or optical readers, machines for transcribing data onto data media in coded form and machines for	11,466.7	2,026,096.4	61	32,502.0	9,110,507.2	38
759	Parts and accessories (other than covers, carrying cases and the like) suitable for use solely or principally with machines falling within groups 751 and 752	9,964.6	1,095,376.2	93	23,529.6	6,108,755.3	47
761	Television receivers (including video monitors and video projectors), whether or not incorporating radio-broadcast receivers or sound- or video-recording or reproducing apparatus	1,168.5	801,493.4	15	2,727.5	1,972,521.0	14
762	Radio-broadcast receivers, whether or not incorporating sound-recording or reproducing apparatus or a clock	267.9	85,424.9	32	3,125.4	2,139,019.7	15
763	Sound recorders or reproducers; television image and sound recorders or reproducers; prepared unrecorded media	439.7	99,276.9	46	3,358.9	1,119,005.8	33
764	Telecommunications equipment, n.e.s., and parts, n.e.s., and accessories of apparatus falling within division 76	28,036.7	3,234,123.9	98	26,810.8	6,170,057.4	48
871	Optical instruments and apparatus, n.e.s.	1,162.4	58,576.9	197	1,396.6	164,769.3	91
872	Instruments and appliances, n.e.s., for medical, surgical, dental or veterinary purposes	5,758.9	994,001.7	56	5,335.2	1,059,555.6	51
881	Photographic apparatus and equipment, n.e.s	2,239.1	190,212.6	115	1,975.4	313,956.2	71
884	Optical goods, n.e.s.	2,350.9	117,037.4	199	2,451.9	289,430.0	88
885	Watches and clocks	1,516.1	85,283.0	179	4,057.8	597,013.1	69
12 industries total		*65708.4*	*9365572.7*	*70*	*109612.9*	*31159547.2*	*35*
12 industries balance				**-43905**			

source: OWN CALCULATIONS based on EUROSTAT DS 018995 database: EU TRADE SINCE 1995 by SITC

2.4.1 EU25 Trade in ICT Goods with China

Successful price competition is largely absent in the bilateral trade of EU25 vis-à-vis China. In fact, it exists only in a very small section of ICT goods trade namely, in photographic and cinematographic supplies (SITC 882), and in most other industries, price competition with China is unsuccessful. EU25 is successful in quality competition in electro diagnostic apparatus (SITC 774) and films (SITC 883).

Unsuccessful price competitiveness in the bilateral trade of EU25 with China can be seen as a direct confirmation of China's comparative advantage (i.e., low costs production). Indeed, when it comes to price competition, China holds a superior position. China is a low cost country hence it is hard to compete with prices of ICT products, except when quality is a priority as in the case of household electrical apparatus and films (SITC 775 and 883).

However, from the perspective of homogeneous products, it is hard to understand why unit values differ up to 10 fold. This is the case with respect to SITC 759, 761-4, SITC 871-2, 874 and 884 as is depicted in Table 11. The unit value of EU25 exports of telecommunication equipment (SITC 764) is 170, while the imports from China only has a unit value of 21, which is 13% of the EU25's export price. In this case, it is hard to believe that these goods are homogeneous. Thus, it is unlikely that many of the goods belonging to the deficit price competition corner are substitutes of each other; in fact, it seems more likely that they belong to different price segments, such as the export of high priced telecom systems and the import of low-cost handsets. The ratio between EU25 export price and the price of imports from China is almost 10 for optical instruments and apparatus (SITC 871), 8 for telecommunications equipment (SITC 764), and 6 for automatic data processing machines, etc. (SITC 752). Therefore, it is questionable whether or not these product markets are homogeneous or if trade in these goods (with an exceptionally large difference between unit values of exports and imports) is caused by market competition or is driven by other sources such as, quality differences or affiliated trade.

Table 11. EU25's Trade with China: Volume and Unit Values of ICT Goods

EU25 - CHINA trade (averages 1996-2004)

PRICE COMPETITIION: low unit value / quantity surplus

SITC		exports value	exports volume	exports unit value	import value	imports port volu	imports unit value
882	Photographic and cinematograp	25.5	21,843.1	15	33.8	13,608.7	25
industry total		*25.5*	*21,843.1*	*12*	*33.8*	*13,608.7*	*25*
1 industries balance				**-8**			

QUALITY COMPETITION: high unit value/ quantity surplus

SITC		exports value	exports volume	exports unit value	imports value	imports volume	imports unit value
774	Electrodiagnostic apparatus for med	175.4	32,929.8	94	28.2	7,193.3	39
883	Cinematographic film, exposed and developed, whether or not	0.1	29.0	65	0.1	13	51
2 industries total		*175.4*	*32929.8*	*53*	*28.2*	*7193.3*	*39*
2 industries balance				**147**			

STRUCTURAL PROBLEM AREA: low unit value / quantity deficit

SIITC	exports value	exports volume	exports unit value	imports value	imports volume	imports unit value

DEFICIT PRICE COMPETITION: high unit value/ quantity deficit

SITC		exports value	exports volume	exports unit value	imports value	imports volume	imports unit value
751	Office machines	57.1	13,588.7	46	737.6	1,342,928.8	12
752	Automatic data-processing machines and units thereof; magnetic or optical readers, machines for transcribing data onto	156.7	16,350.3	103	5,639.3	3,232,852.4	17
759	Parts and accessories (other than covers, carrying cases and the like) suitable for use solely or principally with machines falling within groups	253.1	27,729.4	98	2,761.8	1,690,522.8	17
761	Television receivers (including video monitors and video projectors), whether or not incorporating radio-broadcast	6.5	3,811.4	45	238.0	134,560.4	16
762	Radio-broadcast receivers, whether or not incorporating sound-recording or reproducing apparatus or a clock	4.5	640.8	66	1,438.7	1,377,010.8	17
763	Sound recorders or reproducers; television image and sound	13.5	2,651.2	59	1,064.2	548,709.0	11
764	Telecommunications equipment, n.e.s., and parts, n.e.s., and accessories of apparatus falling	2,316.2	136,025.0	170	4,717.3	2,869,625.1	21
771	Electric power machinery	317.9	174,048.0	18	1,018.2	958,257.2	17
772	Electrical apparatus	880.5	300,069.3	29	938.4	685,108.0	11
773	Equipment for distributing electricity	189.0	297,457.1	7	516.5	1,141,531.2	5
775	Household-type electrical and non-electrical equipment, n.e.s.	76.9	80,816.0	5	1,882.4	3,963,792.8	5
776	Thermionic, cold cathode or photo-c	704.2	56,897.3	10	732.5	88,694.4	5
778	Electrical machinery and apparatus,	353.7	228,110.4	15	2,334.4	2,943,994.9	8
871	Optical instruments and apparatus, n.e.s.	24.8	1,670.2	155	138.1	86,167.4	16
872	Instruments and appliances, n.e.s., for medical, surgical, dental or	94.7	17,075.7	61	190.0	195,353.2	10
874	Measuring, checking, analysing and	640.9	63,091.1	101	355.4	236,598.2	16
881	Photographic apparatus and equipment, n.e.s	84.5	9,272.6	89	396.0	110,840.6	37
884	Optical goods, n.e.s.	46.2	2,437.4	201	424.4	111,244.6	39
885	Watches and clocks	18.7	3,661.3	54	794.9	436,251.7	19
19 industries total		*6239.6*	*1435403.4*	*43*	*26318.0*	*22154043.6*	*12*
19 industries balance				**-20078**			

source: OWN CALCULATIONS based on EUROSTAT DS 018995 database: EU TRADE SINCE 1995 by SITC
location:INTICT-DATA_eu25_china_76_5771TM_82

2.4.2 EU25 Trade in ICT Goods with Japan

Japan is known as one of the few high tech countries par excellence where high labour costs are compensated by high productivity and a high level of technology. This might explain why there is a structural problem of EU25 with respect to its trade with Japan. While six ICT products have lower prices in the EU25 as compared to Japan, they exhibit a trade deficit. In this case, lower prices most likely implies a different level (probably lower) of quality. The bilateral trade in ICT products of EU25 vis-à-vis Japan is very well characterised by (unsuccessful) price competition. In addition, in this case, as in the case of the trade with China, unit values differ too greatly to draw the conclusion that EU25 lacks price competitiveness.

Table 12 shows the following: the bulk of the trade with Japan is characterised by deficient price competition but the differences between unit values are sometimes simply too large to assume product homogeneity. This is the case with automatic data processing machines, etc. (SITC 752), parts and accessories for 751 and 752 products (SITC 759), telecommunication equipment, etc. (SITC764), thermionic cold cathodes, etc. (SITC 776), optical instruments (SITC 871), and optical goods (SITC 884).

It is hard to believe from the perspective of homogeneity of products, that unit values can be 8 to 14 fold. Table 12 shows these remarkable differences, and the homogeneity assumption is in this case, also rather questionable whereas the possibility of quality differences is quite likely.

The trade balance with Japan is minus €19.6 billion, mainly originating in the southeast corner of Table 12.

2.5 International Trade in ICT and Other Services

The performance and perspectives for ICT services are different than those for ICT goods. The service trade surplus of EU25 is surging at 20% per year (over the period 1993-2003). However, not every EU country gains from this trade; in fact, it includes only a few countries with unique specialisations, many of which are remarkably members of the smaller countries of the EU. For example, the small open economies like Belgium, Ireland, and Sweden, are more specialised in the exports of computer and related services as compared to larger economies such as, the UK and the US.

ICT services embrace a rich variety of services, including computer data and news-related service, transactions between residents and non-residents, databases, data processing, and provision of processing services on a time-share or specific (hourly) basis. They also include the operation and maintenance of ICT facilities of clients on a continuing basis, hardware consultancy, software implementation—including design, development, and programming of customized systems, maintenance and repair of computers and peripheral equipment, news agency services—including provision of news, photographs, and feature articles to the media, and direct, non-bulk subscriptions to newspapers and periodicals.

Table 12. EU25's Trade with Japan: Volumes and Unit Values of ICT Goods

EU25 - JAPAN trade (averages 1996-2004)

PRICE COMPETITIION: low unit value / quantity surplus

SITC		value	exports volume	unit value	import value	imports import volume	unit value
775	Household-type electrical and non-electrical equipment, n.e.s.	244.8	150,595.8	16.3	61.1	36,562.2	16.7
industry total		*244.8*	*150595.8*	*16.3*	*61.1*	*36,562.2*	*16.7*
1 industries balance				**184**			

QUALITY COMPETITION:

SITC		value	exports volume	unit valu
883	Cinematographic film, exposed and developed, whether or not incorporating	5.9	572.4	
1 industries total		*5.9*	*572.4*	
2 industries balance				

STRUCTURAL PROBLEM AREA: low unit value / quantity deficit

SIITC		value	exports volume	unit value	value	imports volume	unit value
761	Television receivers (including video monitors and video projectors),	11.8	2056.2	57.2	604.0	44577.1	135.5
771	Electric power machinery						
773	Equipment for distributing e;ectricitry..	67.5	35645.0	18.9	202.5	79962.5	25.3
874	Measuring, checking, analysing and c	919.0	148,816.8	62	1,422.4	176,727.5	80
881	Photographic apparatus and equipment, n.e.s	129.9	10,381.3	125	763.1	59,678.2	128
882	Photographic and cinematographic su	132.6	102,374.6	13	757.6	325,731.9	23
6 industries total		*1260.7*	*299273.9*	*42.1*	*3749.6*	*686677.2*	*54.6*
6Industries balance				**-2489**			

DEFICIT PRICE COMPETITIO

SITC		value	exports volume	unit valu
751	Office machines	23.1	5,850.3	
752	Automatic data-processing machines and units thereof; magnetic or optical readers,	869.5	35,931.3	
759	Parts and accessories (other than covers, carrying cases and the like) suitable for use solely or principally with machines falling within groups 751 and 752	687.7	28,412.5	
762	Radio-broadcast receivers, whether or not incorporating sound-recording or reproducing apparatus or a clock	4.6	553.2	
763	Sound recorders or reproducers; television image and sound recorders or reproducers; prepared unrecorded media	16.3	1,829.8	
764	Telecommunications equipment, n.e.s., and parts, n.e.s., and accessories of	850.0	40,231.9	
772	Electrical apparatus	335.1	51,692.1	
774	Electrodiagnostic apparatus for medical …	345.7	24,313.4	
776	Thermionic, cold cathode or photo-cathode	692.7	9,470.2	
778	Electrical machinery and apparatus, n.e.s.			
871	Optical instruments and apparatus, n.e.s.	145.3	4,851.6	
872	Instruments and appliances, n.e.s., for medical, surgical, dental or veterinary	618.1	44,586.5	
874	Measuring, checking, analysing and controll	919.0	148,816.8	
884	Optical goods, n.e.s.	257.4	8,126.8	
885	Watches and clocks	90.3	2,516.6	
15 industries total		*5854.9*	*407183.0*	
15 industries balance				-

source: OWN CALCULATIONS based on EUROSTAT DS 018995 database: EU TRADE SINCE 1995 by SITC location:INTICT-DATA eu25 japan 76 5771TM 82

Within this rich variety, some services are scale intensive such as, database services and news provision, while others are scale extensive such as, software implementation. The same can be said about the knowledge intensity of these services.

Consequently, there are large unleashed potentials for all countries in these services. The reason being that ICT services cover the whole range from scale and knowledge intensive to scale and knowledge extensive services, giving ample opportunity to exploit comparative advantages without being bound by scarce factors such as skilled labour. This is especially true if advantages in communication technologies can further reduce transaction costs for services, as pointed out in the previous chapter. Although the current levels of trade are quite low in absolute terms, they are quite substantial as a percentage of value added of the ICT sector trade in services (18% for exports and 10% for imports in 2004, see Table 6), not least due to high growth rates of exports.

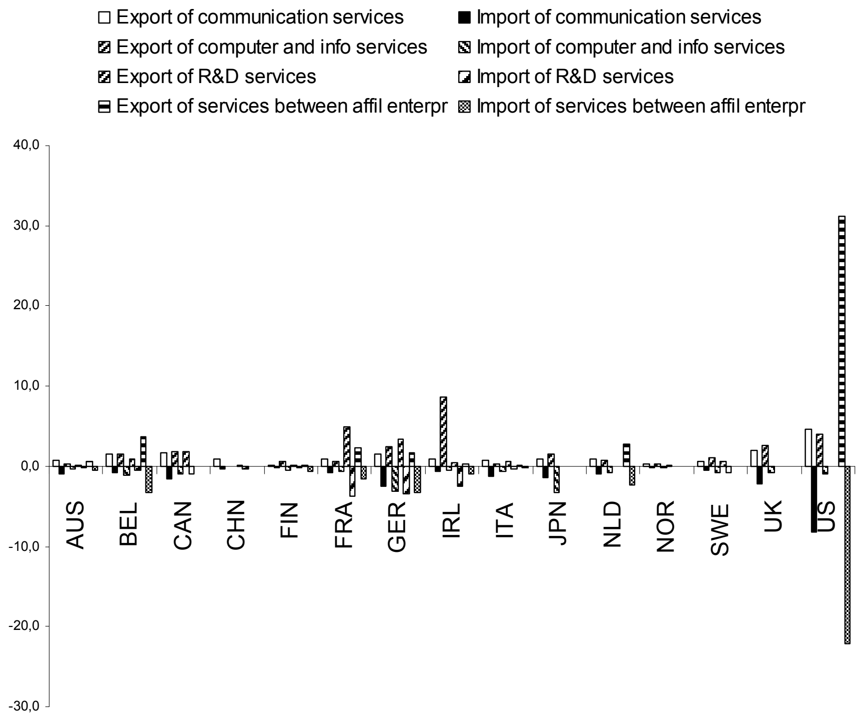
The trade in ICT services (i.e. communication and computer and related services) is shown in Figure 14. The bars in this figure represent exports and imports in billion of euros for each country in terms of communication services, computer and related services, R&D services, and services between affiliated companies. Note that the data is not complete: the US lacks observations on R&D services and the UK also lacks data on services between affiliated enterprises. Furthermore, Denmark, Portugal and Spain show no data on services, and Greece, Poland, Slovakia, and Hungary are not completely covered by observations on trade in ICT services. Despite these imperfections, the figure provides an instantaneous overview on the proportions of global trade in ICT and some other services that are of interest for this study.

Germany (GER), UK, and US are relatively large exporters and importers of *communication services* (the first and second bars from the left for each country), and Belgium (BEL), Canada (CAN), Ireland (IRL), the Netherlands (NLD), and Sweden (SWE) acting as small open economies, also exhibit relatively large trade flows in these services.

Ireland has specialised in *computer and related services* as can be seen in Figure 14. Other relatively large exporters of these services include Belgium (BEL), Canada (CAN), Germany (GER), UK, and US.

France (FRA) and Germany (GER) are relatively large exporters of *research and development services*. However, and unfortunately, there is no data available on this item for countries such as, the UK and US.

Finally, the US has a remarkable position in *trade in services between foreign affiliations* where exports easily beat imports. Trade between foreign affiliations is relatively intense in Belgium (BEL), France (FRA), Germany (GER), and the Netherlands (NLD), note that data for the UK is missing.

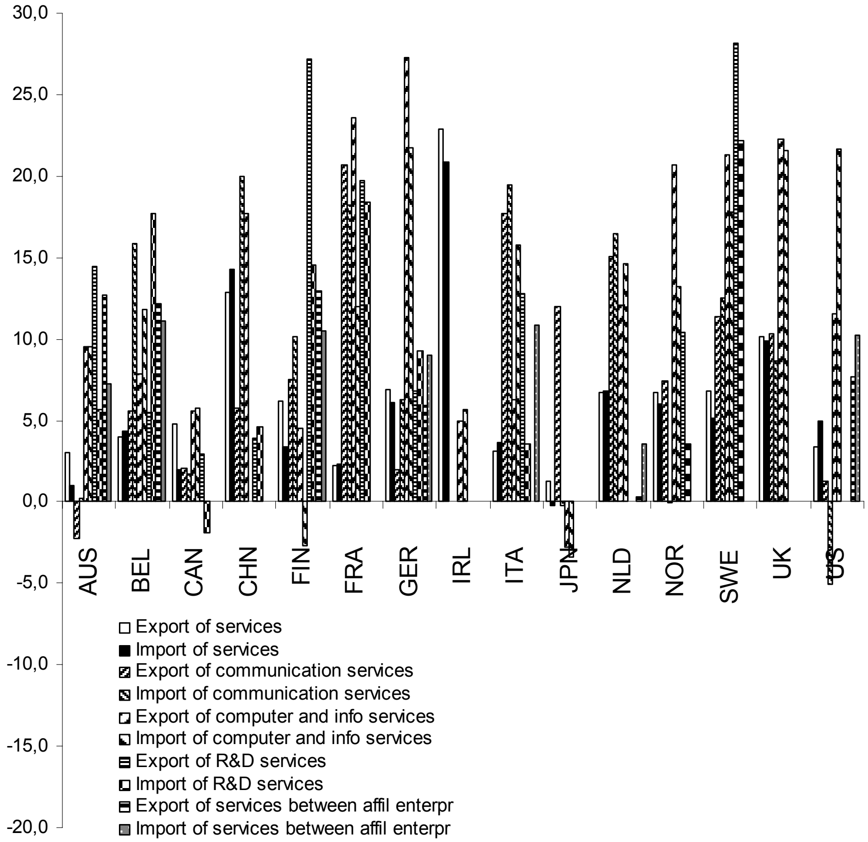


Source: Balance of Payment Statistics, IMF.

Fig. 14. Export and Import of ICT-And Some Other Services in Selected Countries in Billion Euros (Average 1992-2002)

So far, we have discussed the average trade flows in services during 1992 and 2002. The growth of these service flows tells a different story, as is depicted in Figure 15. Apart from the services mentioned earlier, this figure also shows the total exports and imports of services. A first observation is that ICT, R&D services, and services between affiliates are much more expansive than the total of trade in services, as is also true in countries where there is broad based trade in services such as, US, UK, Germany (GER), and France (FRA). A second observation is that China (CHN) turns out in general, to be relatively expansive in trade in services in the import of communication and the export of computer and information services, but not in R&D services. Unfortunately, data on the trade between affiliated enterprises is not available for China (CHN).

Small scale economies such as Poland (POL) and Czech Republic (CZE), show surging trade in computer and information services and, especially in the case of Poland, services between affiliated enterprises are booming, most likely due to the impact of EU25 ascension. Surging trade in computer and information services is also found in larger economies such as, France (FRA) and Germany (GER). More growth is possible if these kinds of services become more liberalised and relevant regulation more harmonised in EU25. Although quite necessary, especially in Poland (POL) and other East European Economies, this may take time to materialise because as it is well known, traditionally these locally provided services are subject to local regulation which favours local provision and discourages standardisation, packaging, and provision from elsewhere or abroad. Elimination of this locally inspired regulation will open up possibilities to provide these services either from a local affiliation in a customised form, or from a distance using the possibilities to network when it comes to packaged services. However, the high growth rates confirm that something is already going on in these protected areas of some economies.



Source: Balance of Payment Statistics IMF

Fig. 15. Growth in the Trade of All and ICT-Services (1992-2002)

2.6 EU25's Trade Position in ICT Activities

In summary, the unit values of EU25 produced ICT goods are relatively high in trade with China, Japan, and the Rest of the World, therefore, it is not likely that improvement in terms of trade is explained by successful price competition with the Rest of the World. If markets are homogenous (at this level of analysis) and the goods are price elastic, then we can expect that high prices will be driven out by low prices and that trade balances will decline. However, what we see is that high prices in EU25 continue while the trade balance of EU25 with the Rest of the World continues without a dramatic decline. In this case, we can therefore conclude that quality competition is not limited to the north-eastern section of Figure 13. A more likely assumption might be that products even on the 3-digit level, are not homogeneous but are differentiated especially in the quality dimension. From a theoretical perspective, the ideas of quality ladders and product fragmentation, developed and presented in the previous chapter, appears in this respect to be relevant.

A key finding is that the assumption of product homogeneity is doubtful given that unit values of exports and imports of some goods differ too much. A ratio of 5 to 14 as shown in Table 10, Table 11, and in Table 12, is simply too large to assume that the regime of price competition is the one that rules. Note that the unit value of exports for all ICT goods is diverging consistently from the unit value of the imports (see Table 8 and Table 7).

Therefore, it is extremely unlikely that these goods are homogeneous. Heterogeneity is more likely as it allows for quality difference or quality ladders and other factors, more than for prices only, e.g. inter-company trade of components between domestic and foreign affiliations. In this context, such a hypothesis says that the lower priced ICT products that are imported by EU25 originate in affiliated enterprises abroad or from subcontractors, and do not compete with EU25 exports of ICT-goods because of their non rival or intermediate character. Various processing stages might be carried out in different countries, and positive comparative advantages that coincide with increasing relative unit values are most likely signs of strengths rather than weaknesses of losing price competition.

The incidence of quality ladders, which in turn promotes specialisation and absolute advantage on the part of the specialized exporters, might be the case and/or rationale. In fact, it is hard to explain why unit values of EU25's ICT goods exports are consistently higher than unit values of imports when volumes remain intact without this interpretation. ICT products might be characterized by product-based learning and absolute advantage and may tend to have important developmental effects on their (host) economies because of the monopoly quasi-rents. Storper (1992) suggests that these industries are inclined to be organized into networks in order to combine several advantages available within these networks such as, specialization and flexibility, thereby facilitating technological learning (Storper, 1992, Leamer and Storper, 2001). Therefore, market shares and their developments and revealed comparative advantages, are the subject of the next section.

3 Selected Characteristics of ICT Activities

3.1 Market Shares and Trends in the International Trade in ICT Goods[10]

Based on market shares in the bilateral trade[11] in ICT goods, it is rather obvious what has happened between 1993 and 2003: US, Japan and Europe[12] lost substantial market shares, while China and the Rest of World[13] gained.

Table 13 depicts these developments concisely. Changes in market shares of imports are shown in the right half of the table. The US is the biggest loser with almost all of its market shares falling. Japanese imports of office, accounting and computing machines (ISIC 30) of US origin, were reduced with 34%-points during 1993-2003. As a consequence, Japan's imports of office, accounting and computing machines (ISIC 30) in 2003, mainly (for more than 80%) came from China/Rest of the World. The picture is similar for radio, television, and communication equipment (ISIC 32).

EU25's losses in market shares as compared with those of the US are relatively small: the exports of office, accounting, and computing machines (ISIC 30) to Japan fell by 7%-points. The exports of medical, precision, and optical instruments (ISIC33) to the other countries fell even more so with 12%-points, however, Japan's imports of these EU25 exported goods and the US imports from EU25 rose with 4%-points as share of the total.

US-Japan trade changed dramatically, not only in office, accounting, and computing machines (ISIC 30), but also in radio, television, and communication equipment (ISIC 32) and in medical, precision, and optical instruments (ISIC33). The US is still the most important supplier of medical, precision and optical instruments (ISIC33), but the Rest of the World became the largest supplier for the other imported ICT goods in Japan.

EU25-US trade also changed substantially however far less than US-Japan trade has. US market share in EU25 for medical, precision and optical instruments (ISIC33) remained fairly stable, however, the import of accounting and computing

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[10] In this section we shift to the OECD bilateral trade database according to ISIC activity classification, hence we leave the product classification of the previous section.

[11] Taken from database [6b], see Appendix B. These data are strictly spoken not comparable with the data used in section 2.2.1, 2.2.2. and 2.2.3 because the former are based on industry data (ISIC classification), while the latter are based on product data (SITC classification).

[12] Europe in this section i. e. Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Netherlands, Poland, Portugal, Spain, Sweden, UK.

[13] The most important economies of the Rest of the World are: Korea, Chinese Taipei and Hong Kong

machines (ISIC 30) and of radio, television and communication equipment (ISIC 32) fell quite substantially.

The trade between Other Countries[14] and the Rest of the World changed substantially where office, accounting and computing machines (ISIC 30) and radio, television and communication equipment (ISIC 32) are concerned. Trade in medical, precision and optical instruments (ISIC 33) changed much less: the US was and still is the largest supplier of medical, precision and optical instruments, for the other countries. However, Japan and the other countries substantially increased their share of these imports.

Table 13 shows that China as a region of origin of ICT manufactures, gains most. In all products and in all destinations, China wins a very substantial market share, especially in Japan. The Rest of the World is the second largest winner of market shares of the trade in ICT manufactures.

Table 13. Import Shares ICT Goods of EU25, Japan, China and Other Countries

EXPORTING COUNTRIES / IMPORTING COUNTRIES	market shares in 1993					change in market share during 1993-2003				
	EU25	Japan	US	China	RoW	EU25	Japan	US	China	RoW
ISIC30										
EU25	0.46	0.14	0.22	0.01	0.17	0.01	-0.08	-0.12	0.12	0.07
Japan	0.13	0.00	0.47	0.03	0.38	-0.07	0.00	-0.34	0.35	0.06
US	0.09	0.37	0.00	0.02	0.52	-0.01	-0.26	0.00	0.27	0.00
Other	0.19	0.15	0.45	0.01	0.21	-0.05	-0.07	-0.24	0.20	0.17
ISIC32										
EU25	0.51	0.18	0.12	0.03	0.16	-0.03	-0.09	-0.04	0.06	0.10
Japan	0.08	0.00	0.41	0.06	0.46	-0.02	0.00	-0.25	0.15	0.12
US	0.06	0.33	0.00	0.05	0.57	0.02	-0.21	0.00	0.14	0.05
Other	0.14	0.14	0.46	0.02	0.24	-0.04	0.01	-0.19	0.09	0.14
ISIC33										
EU25	0.50	0.10	0.23	0.02	0.16	0.01	-0.03	-0.01	0.02	0.01
Japan	0.21	0.00	0.46	0.03	0.29	0.04	0.00	-0.13	0.12	-0.03
US	0.31	0.30	0.00	0.04	0.35	0.04	-0.14	0.00	0.05	0.05
Other	0.33	0.10	0.47	0.01	0.09	-0.12	0.04	-0.09	0.04	0.12

Source: OECD STAN bilateral trade database, Vol 2005, release 01, ISIC Rev 3.

To give some examples, in 2003, 63% of the imports radio, TV's, etc. (ISIC 32) of US, and 58% of those of Japan came from the Rest of the World-economies. The latter group mainly includes Korea, Chinese Taipei, and Hong Kong.

Table 14 depicts the import shares of the European Tigers (Czech Republic, Hungary, Ireland and Poland) and the rest of Europe. The rows depict imports shares of the countries mentioned in the left hand side of the table, and the columns represent the exports of a region. European Tigers held very modest market shares in 1993, where 4% of the imported computers, etc. (ISIC 30), in the EU-Rest came from the European Tigers countries. Over the time period, the situation changed drastically where the shares of European Tigers in EU-Rest increased from 4% to 12% for computers (ISIC 30), from 1% to 7% in radio, TV, etc. (ISIC32), and from 2 to 5% for medical devices (ISIC 33). Market shares of the EU Rest declined, often in favour of market share in the imports of the Rest of the World.

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[14] Most import of these economies are China, Chinese Tapei (Taiwan) and Korea

Table 14. Import Shares of ICT Goods of EU-Tiger and Rest of Europe

EXPORTING COUNTRIES / IMPORTING COUNTRIES	market shares in 1993			market shares in 2003		
	EU-Tigers	EU-Rest	Rest of World	EU-Tigers	EU-Rest	Rest of World
ISIC30						
EU-Tigers	0.01	0.34	0.65	0.04	0.24	0.72
EU-Rest	0.04	0.43	0.53	0.12	0.38	0.50
ISIC32						
EU-Tigers	0.02	0.69	0.29	0.06	0.35	0.59
EU-Rest	0.01	0.48	0.50	0.07	0.41	0.51
ISIC33						
EU-Tigers	0.03	0.64	0.33	0.03	0.40	0.56
EU-Rest	0.02	0.47	0.51	0.05	0.45	0.49

Source: OECD STAN bilateral trade database, Vol 2005, release 01, ISIC Rev 3

3.2 Revealed Comparative Advantage in ICT Goods and Services

Revealed comparative advantage as first introduced by Balassa (1965), focuses on exports. Equation 1 describes revealed comparative advantage as the ratio between the share in a nation's export of a certain good and the share this good has in the world exports.,

Equation 1 Revealed comparative advantage defined (Balassa)

$$RCA_{ij} = (X_{ij} / \sum_i X_{ij}) / (\sum X_{ij} / \sum_i \sum_j X_{ij})$$

Laursen, 1998 has shown that using RCA in empirical (econometric) work, it should always be transformed in such a way that it becomes a symmetric variable. His conclusion is based on empirical evidence, using a normality test of the error terms from regressions.[15] RCSA compared to RCA proves to be a superior measure to describe comparative advantages of countries, especially due to its clearer interpretation. When a RSCA indicator approaches the value 1.0, then a country has reached its maximum revealed comparative advantage, and when the minimum value is minus 1.0, RCA on the other hand is unbound.

For these reasons, we adopt the transformation proposed by Laursen 1998, as in Equation 2,

[15] Based on the Jarque-Bera test

Equation 2 Laursen transformation of RCA

$$RSCA_{ij} = (RCA_{ij} - 1)/(RCA_{ij_{-1}} + 1)$$

Revealed comparative advantage differs widely among the countries in the group. Figure 16 gives an example of RCA in computer manufacturing (ISIC 30) in 26 countries during 1993–2003. Ireland and the Netherlands exhibit relatively high RCA in ISIC30 (RCA_30). Japan, Korea, Mexico, UK and US, also have a considerable RCA_30, and some of the other countries who have low RCA_30 are rising stars such as, Czech Republic, however, far less so than Korea, Mexico, and the Netherlands. RCA_30 is falling in Japan and stable to falling in UK and US.

The accompanying figures of revealed symmetric advantages (RSCA) are given in Figure 17 in which comparative advantage (RCA) is scaled to values between 1 and -1. A limited number of countries exhibit positive values, meaning that these countries export more than the average country. Countries such as, Greece, Turkey, Poland, and Portugal export almost no computers therefore their RSCA_30 is close to minus 1. When RSCA_30 is close to 1, this means that RCA is extremely high, in this sense, Ireland is a top performing economy.

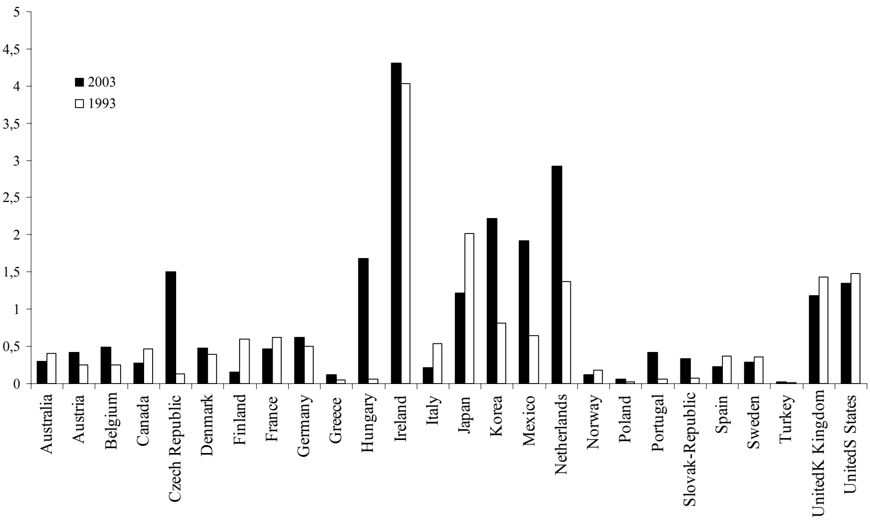


Fig. 16. Revealed Comparative Advantages in Computer Manufacturing (ISIC 30)

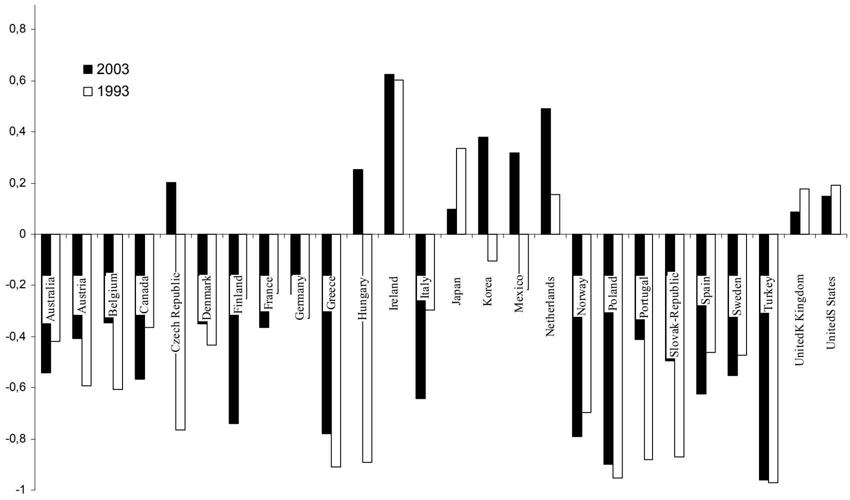


Fig. 17. Revealed Symmetric Comparative Advantages in Computer Manufacturing (ISIC30)

Revealed symmetric comparative advantages in 1993 in all ICT industries are given in Figure 18. In 1993, countries with a strong export position based on RSCA were scarce. However, there were exceptions such as those with Ireland which held a strong position in ISIC30, together with Japan, the Netherlands, UK and US. Japan, Korea, Mexico, Sweden, and US held strong RSCA positions in ISIC 32, and Germany, Ireland, Japan and US held strong RSCA positions in the medical, precision, and optical instruments industry (ISIC 33). No country held a strong position in telecommunication services, while Belgium, Canada, Finland, Hungary, Ireland, and Japan were reasonably strong in computer services (ISIC 72) at that time.

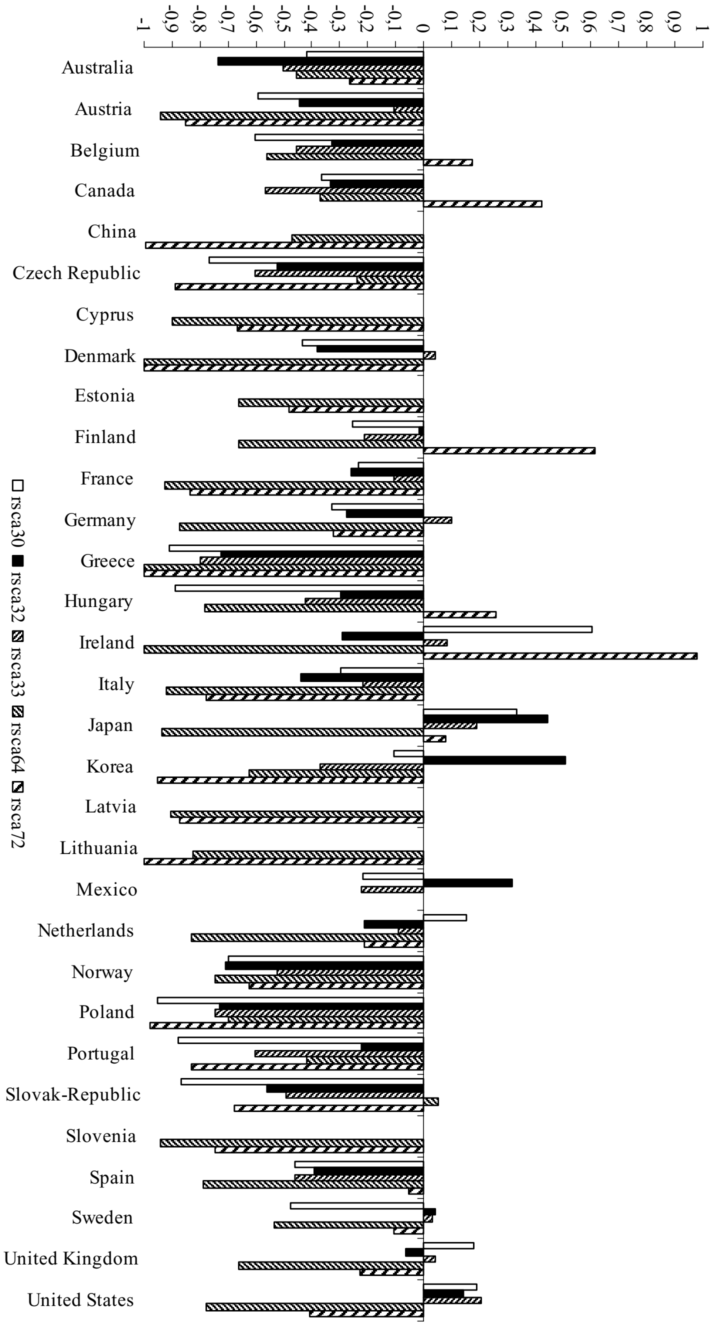
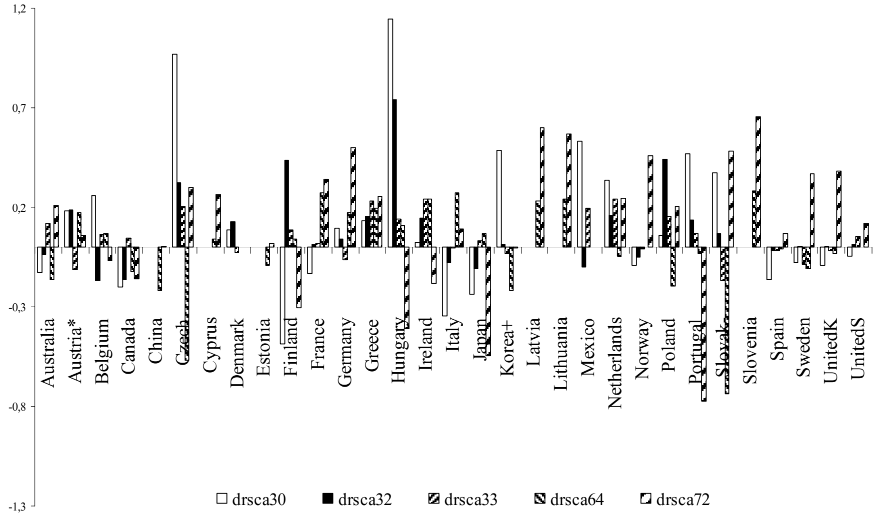


Fig. 18. Revealed Symmetric Comparative Advantages in All ICT Industries in 1993

Since 1993, some new member states improved their RSCA position considerably. Figure 19 gives an impression of the changes in the RSCA position of the countries in the group considered here. Czech Republic, Hungary, Latvia, Lithuania, Poland and Slovenia exhibit huge shifts in RSCA of several kinds (except of course ISIC 64). Other countries improved on RSCA as well such as, Finland with respect to ISIC32, France and Germany with respect to ISIC 64 and ISIC72, Korea with respect to ISICI30, the Netherlands with respect to all sectors, Slovak Republic with respect to ISIC 30 and ISIC72, and finally, Slovenia, Sweden, UK and US with respect to ISIC 72.

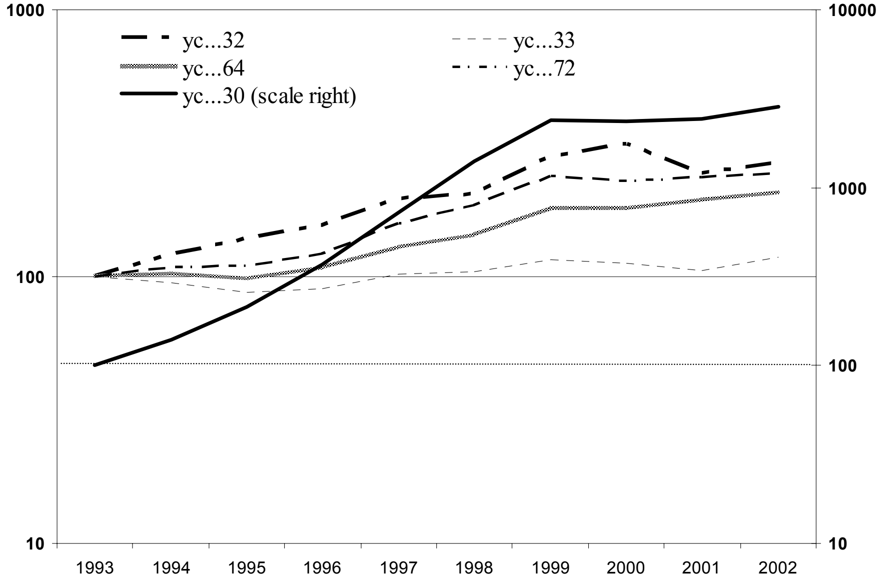


drsca30 = the change in RSCA during 1993-2003 or in arithmetic terms rsca30(2003)-rsca30(1993), etc.

Fig. 19. Change in Revealed Symmetric Comparative Advantage in ISIC 30, 32, 33, 64 and 72 During 1993-2003

3.3 Value Added

Global demand for ICT products and services expanded rapidly during 1993–2002. Therefore, the volume of value added in the countries we present showed impressive, mostly double-digit, volume growth during 1993-2002. Volume of value-added included improved quality and capacity of ICT goods and services. Figure 20 depicts the development of value added in the ICT industries. Value added in the production of computers (ISIC 30) increased annually at an astonishing 53%. Radio and TV (ISIC 32) exhibited an annual growth rate of 17%, while medical equipment (ISIC 33) grew 2.2%. However, since 1999, these growth rates levelled off as can be seen in the figure**.** The annual growth of value added in the manufacturing of computers (ISIC 30) fell to 5.7% annually, and communication services (ISIC 64) levelled off to 4.5%. Electrical machinery (ISIC31), and radio and TV (ISIC 32) even showed a contraction of value added of approximately 2% annually.



[a]Aggregate value added in Euros. The economies are Austria, Australia, Belgium, Canada (except ISIC 73), Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Netherlands, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Chinese Taipei, UK and US.
Source: GGC 60 industry database
[b] YC.. 30 is plotted against the right hand scale which runs from 10 to 10,000, this means that value-added in ISIC30 rose from 100 in 1993 to 2800 in 2002 a compounded growth rate of 37%.

Fig. 20. Aggregate Value Added in 25 Countries in ICT Activities, Logarithmic Scale (Double Logarithmic Scale[b], 1993=100)

The value added of an hour of labour gives a good indication of the productivity of labour and capital, without the possible distorting effect of different methods of (price) deflation. It is obvious in Figure 21, that differences in value added per hour among countries are greater than the differences between industries within the same country.

While the Czech Republic (CZE), Hungary (HUN), Poland, and Slovak Republic (SVK) exhibit relatively low value added per hour, Japan (JPN) is the real 'value added' champion among the 24 countries exhibited in Figure 21. This is consistent with Japan being on top of the quality ladder and the former four countries, at the bottom.

Intra industry differences within countries are sometimes large, which is very likely the effect of specialisation. This is the case in computer and related activities (SITC 72) in Belgium (BEL), Ireland (IRL), and Chinese Taipei (TWN), but also in the radio, TV and communication equipment industry (SITC32) in Finland (FIN), in the office accounting and computing machinery industry (SITC30) in France (FRA), in post and telecommunication (SITC64) in Japan (JPN), and finally, in the medical, precision and optical equipment industry (SITC33) in Poland (POL).

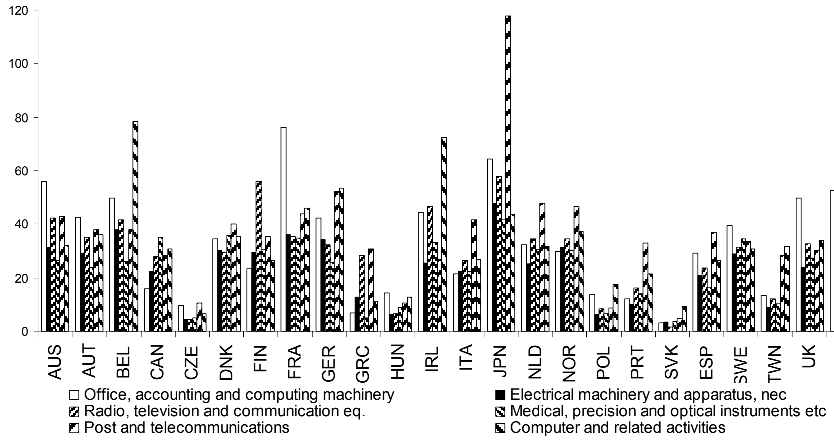


Fig. 21. Value Added In ICT Activities at Current Prices; In Euros per Hour of Labour in 24 Countries

3.4 Quality of Labour and Value Added

Quality of labour is an important element of the competitive position of an industry in a country. However data on the skill levels in the ICT industries are impossible to compile from the available sources within the resources of this project. More or less comparable data on labour quality for France, Germany, the Netherlands, UK and US, can however be derived from O'mahony and Van Ark (2003). They published data on growth of labour quality which is available for 26 industries. These numbers express the growth in the wages per skill level of employed people using information on wages by educational type (Table 15 provides the details). Table 15 exhibits the growth in skill-adjusted labour input minus growth in total hours worked, in indices for ICT manufacturing (ISIC 30-33), Communication (ISIC 64), Real Estate and Business services (ISIC 70-74), and the total economy for these five countries.

Table 15. Labour Quality in 2000, 1990=1.0

ISIC	France	Germany	Netherlands	UK	US
ISIC 30-33	1.08	1.06	1.02	1.06	1.08
ISIC 64	1.01	1.09	1.06	1.09	1.04
ISIC 70-74	1.04	1.02	1.05	1.06	1.05
total economy	1.06	1.01	1.03	1.07	1.03

Source: O'Mahony and Van Ark (2003)

Obviously labour quality has grown in all countries during 1990-2000. This growth has been stronger in the UK and France than in the other countries. Quality of labour in ISIC 30-33 rose more than average in France, Germany, and US. Not a single conclusion can be drawn from the differences between the industries, however, the picture gives rise to the idea that the accents are different in these countries. These growth rates might be important, and it is likely that Germany as well as the US improved their competitiveness by improving labour quality in ISIC 30-33 more than the other countries did. However the table hides the *level* of labour quality, therefore, we revert to a more general analysis of the significance of labour quality for the production of ICT manufacturing industries.

One way to obtain a more or less comparable level of educational attainment in general, is by sourcing the available data in Eurostat's Statistical yearbook. The measure of educational attainment we derive from this source is the share of people in the total adult population aged between 25 and 64 years who have completed at least upper secondary education.[16] This indicator aims to measure the share of the population that is likely to have the minimum necessary qualifications for active participation in social and economic life.[17]

Figure 22 shows that in most of the European countries there is a strong correspondence[18] between this level of educational attainment and value added per employee, with the exception of Czech Republic, Hungary, Poland and Slovak Republic. The figure exhibits value added per employee (average 1992-2002) in the three ICT manufacturing industries (ISIC 30, 32 and 33) and the general educational attainment of at least upper secondary education in the European countries (average 1999-2002).

The former COMECON countries, Czech Republic (CZE), Hungary (HUN), Poland (POL) and Slovak Republic (SVK), recently became EU-member states,

[16] Eurostat Statistical Yearbook , Eurostat Statistical Yearbook, 2005, table cca 23312

[17] The Statistical yearbook warns that it should be noted that completion of upper secondary education can be achieved in European countries after varying lengths of study, according to different national educational systems, indicating that perfect comparability is not possible.

[18] The correlation between this level of educational attainment and vale added per employee in ISIC 30, 31, 32 and 33 is 0.47, 0.80, 0.53 and 0.65 respectively for the European countries with the exception of the Czech Republic, Hungary, Poland and the Slovak Republic.

and a rather high educational attainment of their population coincides with rather low value added per employee.[19] This entails an enormous unleashed potential for catching up with respect to productivity in ICT manufacturing. The COMECON - EU25 transition is an important issue in these countries and is boosting production in ICT industries especially in the Czech Republic and in Hungary

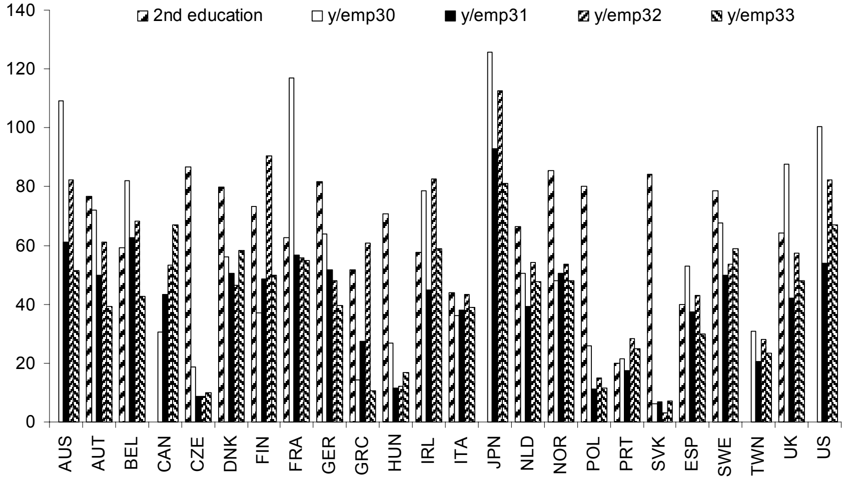


Fig. 22. Educational Attainment and Value Added Per Employee in ICT Manufacturing Industries

Figure 19 features this impressive growth in revealed comparative advantage in ICT manufacturing exports (ISIC 30 and 32) in these countries. For example, the Hungarian COMECON-EU25 transition is largely impacted by inward FDI by foreign global multinational networks rather than by privatisations. These inward FDI flows mainly target the ICT manufacturing and the automotive industries causing booming exports of these goods and enormous progress in labour productivity (Szanyi, 2006). These developments might indicate that their productivity levels are converging which is a topic that is discussed in the next section.

3.5 Level and Growth of Labour Productivity

There seems to be no clear relation between the level of labour productivity and productivity growth in all ICT industries, at least during the period 1992-2002. If the initial level of labour productivity in a country is low and its growth is higher than in countries with higher initial labour productivity, then we can speak of

[19] The correlation between the level of educational attainment and value added per employee in fact is negative for these countries.

catching up of the low productive countries and hence the labour productivity levels among these countries that converge.

Barro and Sala-I-Martin (1995 and 1996) make a distinction between two types of convergence: β-convergence and σ-convergence. The former occurs when the dispersion of income per head across a group of nations diminishes over time. The latter occurs when low-income nations grow faster than high income and there is no σ-convergence without β-convergence whatsoever (Young, Higgins and Evy, 2003). Using these insights to explain the growth of labour productivity by its previous level, we find a clear-cut relation in the sense that low levels of productivity coincide with high growth rates, while high levels coincide with lower growth rates. But β-convergence is just one of the two conditions under which convergence in levels of productivity may occur in the future. Pooled estimation of the convergence relation, indeed gives sufficient evidence for β-convergence of productivity levels among the 18 countries[20] that are present in the pool, with the possible exception of communication services (ISIC64), the results of which are exhibited in Table 16.

Table 16. Productivity and β-Convergence 1993-2002

	ISIC 30	ISIC 31	ISIC32	ISIC33	ISIC 64	ISIC 72
Lagged productivity	-0.500	-0.160	-0.259	-0.202	-0.045	-0.084
t-.value	-7.9	-4.1	-5.6	-4.4	-1.4	-2.2
Adj R-square	0.30	0.23	0.20	0.22	0.22	0.15

Note: Estimated for 18 countries in a pooled time series regression with cross section weights for the residuals. For this small sample panel corrected standard errors methodology has been applied in order to get more robust parameters.

ICT activities located in mature economies show, on the average, absolute high levels of productivity and low growth, while for example, the new member states exhibit low levels and high growth of productivity. Japan leads in all ICT industries except one, where Belgium exhibits the highest productivity in ICT services (ISIC72) and Japan, second highest. Austria, France, Finland, Denmark, Germany, Ireland, Canada, and US belong to the high productivity countries while Slovak Republic, Czech Republic, Poland, Greece, and Hungary belong to the low productivity countries. These differences are exhibited in the figures 23 - 27 below. In these figures, total growth of labour productivity during 1992-2002 is drawn along the horizontal axis, while the average level of productivity is drawn along the vertical axis.

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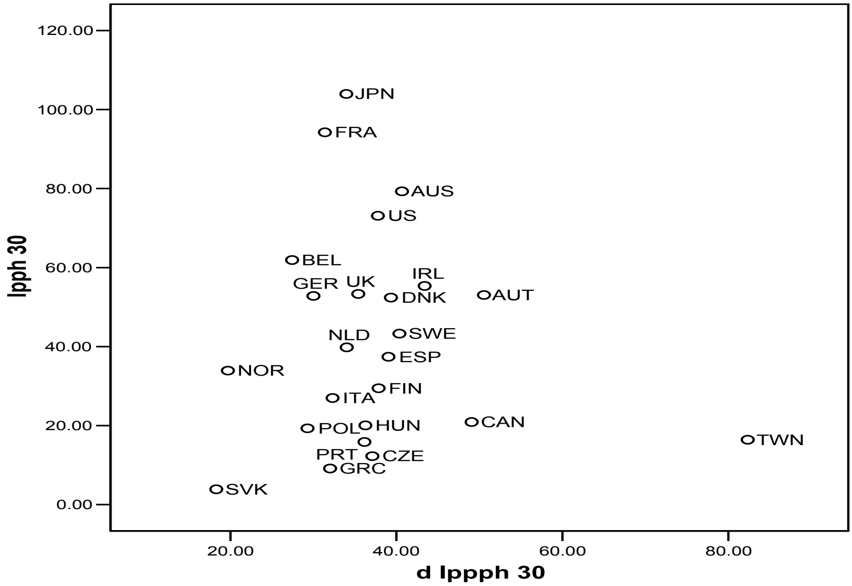
[20] Australia, Belgium, Canada, Denmark, Czech Republic, Finland, France, Germany, Ireland, Italy, Korea, the Netherlands, Norway, Poland, Spain, Sweden, UK and US

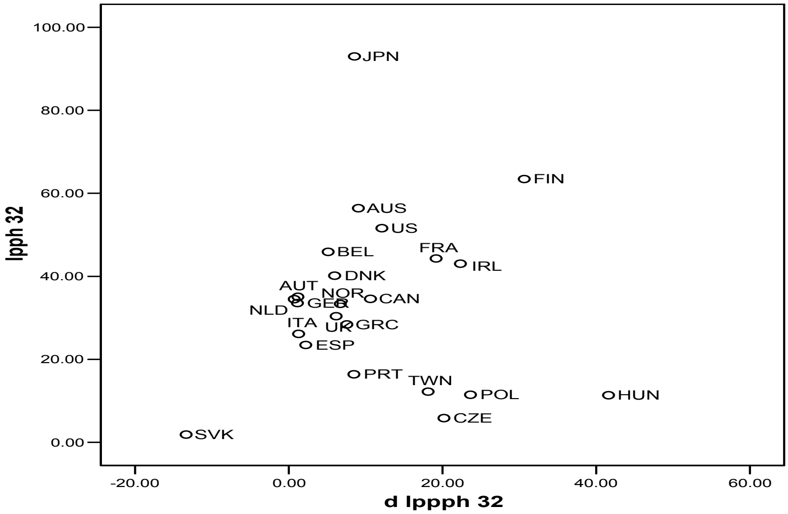
Figure 23 exhibits growth and level of labour productivity in the countries contained in the pool. High productivity level countries such as, Japan, France, Austria, and US combine high levels of productivity (LPPH 30) with moderate growth of labour productivity (d LPPH 30 on the horizontal axis). Chinese Taipei (TWN) is an example of a country that shows very fast growth but still lags behind in the level of productivity.



Note: lppph30 = labour productivity per hour in current prices in ISIC 30 industry, dlppph= annual percentage change in lppph30

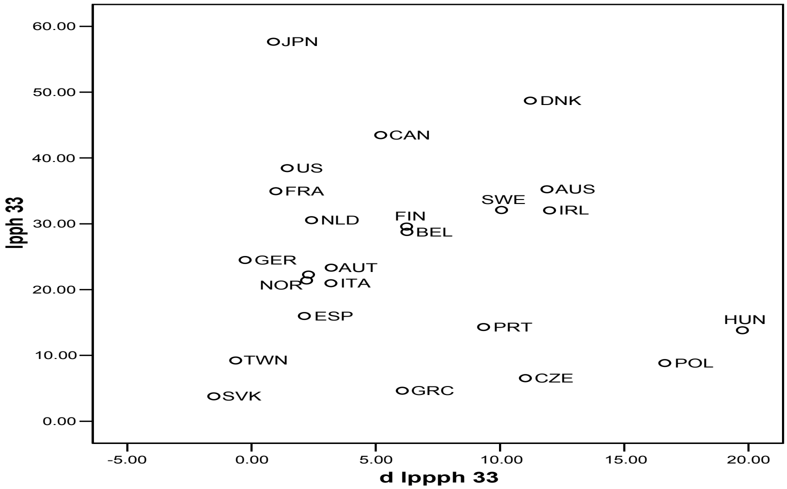
Fig. 23. Average Level and Cumulated Growth of Value Added Per Hour in Office, Accounting and Computing Machines Manufacturing 1992-2002

It is obvious, from Figure 24, that Japan, and to a lesser extent, Finland and Austria, are the leaders of the pack as far the level of labour productivity in radio, television and communication equipment manufacturing is concerned. Laggards are Hungary, Czech Republic, Poland, and Chinese Taipei. Note that the difference in labour productivity growth between Japan and Hungary is more than 30% over the period 1992 -2002.



Note: lppph32 = labour productivity per hour in current prices in ISIC 32 industry, dlppph= annual percentage change in lppph

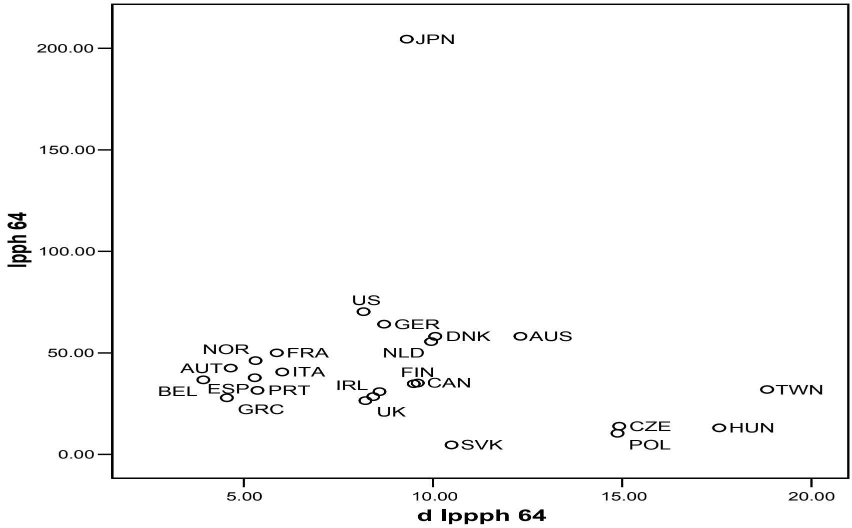
Fig. 24. Average Level and Cumulated Growth of Value Added Per Hour in Radio, Television and Communications Equipment Manufacturing, 1992-2002



lppph33 = labour productivity per hour in current prices in ISIC 33 industry, dlppph= annual percentage change in lppph

Fig. 25. Average Level and Cumulated Growth of Value Added Per Hour in Medical, Precision and Optical Instruments Manufacturing, 1992-2002

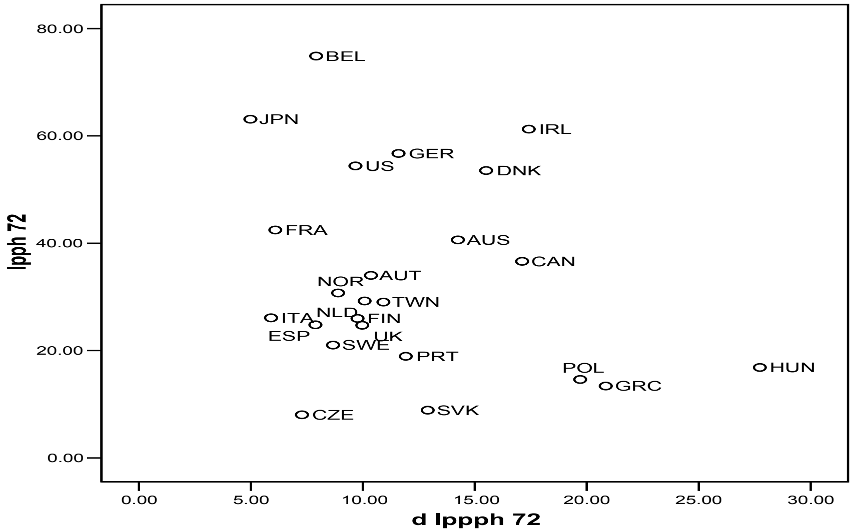
Japan, Denmark, Canada and US exhibit high levels of productivity in medical, precision and optical instruments manufacturing (see Figure 25), while Hungary, Poland and Czech Republic pair low level with high productivity growth. Note that the growth as well as the level of labour productivity, is considerably less than in ISIC 30 and ISC 32, indicating that production of medical and optical instruments is different from manufacturing computer and radios and TV's (ISIC 33). Note that the difference in labour productivity growth between Japan and Hungary is more than 30% over the period 1992 -2002



lppph64 = labour productivity per hour in current prices in ISIC 64 industry, dlppph= annual percentage change in lppph64

Fig. 26. Average Level and Cumulated Growth of Value Added Per Hour in Post En Telecommunications Services, 1992-2002

To conclude, information from these graphs and from Table 24 indicates that β-convergence of labour productivity exists in almost all ICT industries, in goods as well as in services production. Japan achieved the highest level of productivity in all ICT activities except in the computer and related services, where Belgium held the lead. However, the picture is varied and/or differentiated for the different ICT activities. The strongest convergence exhibits the manufacturing of computers (ISIC 30), the slowest (or no convergence at all) in communication services (ISIC 64), and the other industries somewhere in between. The new member states show clear signs of convergence in productivity.



lppph72 = labour productivity per hour in current prices in ISIC 72 industry, dlppph= annual percentage change in lppph72

Fig. 27. Average Level and Cumulated Growth of Value Added Per Hour in Computer Services and Related Activities, 1992-2002

3.6 Unit Values, Revealed Comparative Advantages and Price and Quality Competition

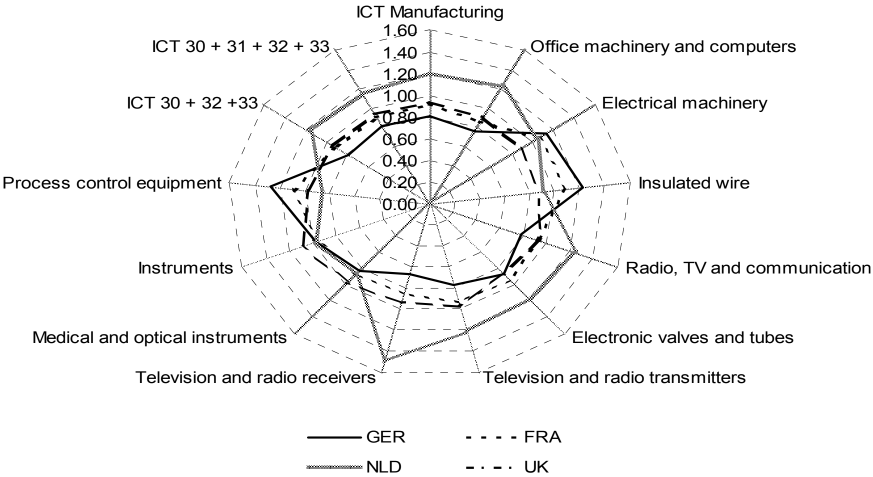
An intriguing question is to what extent revealed comparative advantages in trade with countries that have a competitive advantage in price or in quality, goes hand in hand with advantages with respect to the resources used in the production of these goods.

In Section 3.4 it was the quality of labour that went hand in hand with the value added per employee engaged in ICT production. The data on the quality of labour in ICT production of Germany, France, the Netherlands, and UK indicated that the quality of labour used in the production of all ICT goods is increasing over the years.

Another source of competitive advantage might be the technological specialisation of countries. Analogous with the definition of RSCA (see Eq.2) Soete (1981) proposed revealed technological advantage (RTA) with regard to patents,[21] especially when it came to patents relevant for innovative ICT goods that buy high prices at the world market. Patent data from the European Patent Office in Figure 28 exhibits the (revealed) technological positions of Germany, France, the Nether-

[21] In equation 1 exports of goods is replaced by patents application and after applying equation 2 we get RTA we use in the figure.

lands and UK with respect to ICT patents. A country has a technological advantage (compared to the Rest of the World) if the value of RTA is larger than 1.0. From Figure 28 it might be clear that the Netherlands occupies a comfortable RTA position with respect to a broad range of ICT products including Office machinery, Radio and TV, Electronic valves and Medical and Optical Instruments. Germany's position is strong with respect to electrical machinery, insulated wire, and process and control equipment. The technological position of France indicates strength in process control equipment, and in the UK, in instruments. Patents of other ICT goods are more or less in line with the world average of 1.0.



Source: Eurostat, Patent applications to the EPO by priority year at the national level by sector of economic activity (NACE class derived through concordance with IPC); total number

Fig. 28. Revealed Technological Advantage (average (1992-2002))

The question here is can we say more about price and quality competition with the help of the data on the quality of labour and revealed technological advantage as presented above?

Table 17 only gives an impression of price and quality competition with respect to Germany, France, the Netherlands, and UK. If we compare Table 17 with Table 10 then it becomes clear that Germany, France and the Netherlands are large contributors to price competitiveness of the EU25. Germany is also a large contributor to the quality competitiveness mentioned in Table 17, as is France, the Netherlands and UK, however, their contribution is much less than Germany's. From the perspective of RTA (see Figure 28) the German strength in electrical apparatus and household type electrical equipment can be understood. The position of the Netherlands as far as electronic valves are concerned can also be understood from its strong RTA position regarding these products, although this is not reflected in radio and TV production.[22] The UK poorly contributes to price competitiveness of ICT goods production in EU25, as is exhibited in Table 17.

UK's overall RTA position is in line with the world's average but this does not seem to be sufficient to be price competitive in ICT goods production, and the possibility that educational attainment in general is less than in Germany and the Netherlands cannot be ruled out as another weakness impacting competitiveness.

So far, the construction of our measure of competitiveness is largely based on the averages and ratios of the past, and if we take a more dynamic position with regard to competitiveness, then the picture changes dramatically. If we define price competitiveness and quality competitiveness more dynamically in terms of growth rates instead of averages of unit values and volumes traded, then we can define successful price competitiveness as a relative decrease in price that coincides with a relative growth of the exported volume. Likewise quality competition is then defined as relative increase in unit values coinciding with a relative increase of exported volumes. Table 18 reports the results.

Regarding dynamic price competition items such as the automatic data processing machines, etc. (SITC 752), the thermionic, cold cathode, etc. (SITC776) and the measuring, checking, analysing and controlling instruments and apparatus n.e.s. (SITC874) are very significant in terms of their impact on the trade balance of EU25 (see e.g. Table 10). These items as far as exports are concerned, grew in value significantly more than the imports, and this is a contribution of all four countries. It is difficult to say what the future will bring however, it is encouraging to know that price competition is not a lost perspective.

The picture is even more pronounced with respect to quality competition. The UK exports of telecommunications equipment, etc. (SITC 764) is an item that is growing much faster in value than its imported counterpart, and is a very significant item regarding its contribution to the trade balance. The other items in Table 18 are 'small change' as far as the trade balance is concerned, but seen from a dynamic perspective, are interesting products because of their fast increasing prices and volumes.

[22] Very likely caused by the fact that Royal Philips is producing TV's and Radios in low wage countries and not in its home country.

Table 17. Trade of Selected Countries with Rest of World in Price Competitive and Quality Competitive ICT Goods

Countries external trade with partner countries outside EU25 (averages 1995-2005)

PRICE COMPETITIION: low unit value / quantity surplus	exports			imports		
SITC	**value(*)**	**volume(**)**	**unit value(***)**	**value**	**volume**	**unit value**
Germany						
772 Electrical apparatus	4580	1208370	38	2657	538721	49
774 Electrodiagnostic apparatus for medical	2019	165244	122	650	47059	138
776 Thermionic, cold cathode or photo-cathode valves and tubes	4747	336362	141	7350	268031	274
873 Meters and counters n.e.s.	215	58685	37	125	32840	38
France						
772 Electrical apparatus	2776	1044658	27	3770	968811	39
774 Electrodiagnostic apparatus for medical	262	25231	104	462	36735	126
873 Meters and counters n.e.s.	120	44657	27	364	66863	54
883 Cinematographic film, exposed and developed, whether or not incorporating soundtrack or	16	2059	80	62	3205	195
Netherlands						
776 Thermionic, cold cathode or photo-cathode valves and tubes	2320	122202	190	1640	30706	534
UK						
873 Meters and counters n.e.s.	137	40979	33	223	57629	39

QUALITY COMPETITION: high unit value/ quantity surplus	exports			imports		
SITC	**value**	**volume**	**unit value**	**value**	**volume**	**unit value**
Germany						
775 Household-type electrical and non-electrical equipment, n.e.s.	1742	1803853	10	936	1514334	6
874 Measuring, checking, analysing and controlling instruments and apparatus, n.e.s	4898	414812	118	3055	290322	105
France						
874 Measuring, checking, analysing and controlling instruments and apparatus, n.e.s	2007	134189	150	1831	122779	149
Netherlands						
774 Electrodiagnostic apparatus for medical	793	52693	151	444	41118	108
UK						
774 Electrodiagnostic apparatus for medical	298	42365	70	236	33816	70

(*) mln euro, (**) 100kg, (***) euro/100kg

source: OWN CALCULATIONS based on EUROSTAT DS 018995 database EUTRADE SINCE 1995 by SITC

Table 18. Trade of Selected Countries with Rest of the World in Dynamic Price and Quality Competitive ICT Goods

Countries external trade with partner countries outside EU25 (averages of % growth 1995-2005)

SITC	DYNAMIC PRICE COMPETITION:low growth in unit value/high growth in volumes	growth of exports(+) value(*)	volume(**)	unit value(***)	growth of imports value	volume	unit value
Germany							
751	Office machines	4	12	-7	0	6	-5
752	Automatic data-processing machines and units thereof; etc	9	13	-3	6	4	2
759	Parts and accessories for machines falling within groups 751 and 752	4	12	-7	6	9	-3
774	Electrodiagnostic apparatus for medical	3	9	-5	7	6	1
France							
752	Automatic data-processing machines and units thereof; etc	3	11	-7	-1	0	-1
776	Thermionic, cold cathode or photo-cathode valves and tubes	3	4	-1	1	-6	7
Netherlands							
763	Sound recorders or reproducers; television image and sound recorders or reproducers; prepared unr	14	24	-9	18	17	0
874	Measuring, checking, analysing and controlling instruments and apparatus, n.e.s	10	13	-3	7	9	-2
UK							
752	Automatic data-processing machines and units thereof; etc	-2	4	-6	1	1	0
763	Sound recorders or reproducers; television image and sound recorders or reproducers; prepared unr	2	13	-10	7	10	-3

SITC	DYNAMIC QUALITY COMPETITION: high growth in unit values/ high growth in volumes	growth of exports value	volume	unit value	growth of imports value	volume	unit value
Germany							
762	Radio-broadcast receivers, whether or not incorporating sound-recording or reproducing apparatus c	12	6	5	-4	-2	-3
871	Optical instruments and apparatus, n.e.s.	11	9	1	6	7	-1
872	Instruments and appliances, n.e.s., for medical, surgical, dental or veterinary purposes	9	9	0	7	8	-1
883	Cinematographic film, exposed and developed, etc	37	18	16	-3	5	-7
France							
Netherlands							
773	Equipment for distributing electricity	14	10	4	7	8	-1
UK							
764	Telecommunications equipment, n.e.s.	19	5	13	8	4	3
884	Optical goods, n.e.s.	14	8	5	5	3	2

(+) average annual growth between 1995 and 2005
(*) mln euro, (**) 100kg, (***) euro/100kg

4 Other Developments in the Trade ICT Goods and Services During 1996-2004

International trade in ICT goods and services is the result of the worldwide supply and demand structure. The firms[23] that supply ICT activities have several options to serve foreign customers: they can export directly to customers, or they can join a network, sell licences to foreign firms or establish foreign subsidiary or affiliation. An important instrument to relocate activities is foreign direct investment (FDI) (See paragraph 2.4 of this chapter and Chapter IV), which essentially acts as a means to avoid trading costs by maintaining capacity in the domestic markets and market abroad. Duplicating facilities or horizontal FDI, leaves the value chain unchanged while vertical FDI fragments the value chain because of the relocation of certain parts of the value chain. (Hanson c.s., 2002) Horizontal FDI is characterised by the *proximity-concentration trade-off* (Helpman c.s., 2004 and Markusen and Venables, 2000), and is driven by productivity, while vertical FDI is characterised by *global production networks* and comes with increasing trade in intermediary goods (and services), trade that is driven by falling trade barriers and liberalisation (Hanson c.s., 2002). Thus, from these theories, we can conclude that dependent on the type of foreign expansion of the firm productivity, deregulation/liberalisation is an important driver of relocation of business activities.

In this section, we aim to explain the comparative advantages and we use revealed comparative advantages of ICT industries in the EU member states as an indicator. In classical theories, comparative advantages function as important drivers of international trade. However, the new trade theories include other factors as well such as, product varieties, imperfect competition, trade costs, and economies of scale, sunk costs and immobile factors (Fujita c.s. 2001 and the previous chapter). Usually, the objects of study are manufactured products, and in most empirical studies, services receive less attention. However, as the evidence in this chapter shows, there is a complementary relationship between international trade and foreign direct investment, which is equally valid for services and consistent with the above described predictions about 'global sourcing'. Hence, the impact of internationalisation of business activities or global sourcing is on both sides: exports as well as imports are affected and eventually, it affects the whole economy. (Van Welsum, 2004 and Van Welsum and Reif, 2005) These possibilities triggered ominous foresights of massive job losses of global sourcing in the US and EU, which were published by leading market research and consultancy firms (especially Forrester Research 2004[24] and McKinsey Global Institute 2004).[25] Whether or not these foresights become reality, what is perfectly clear is

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[23] Usually the term firm in the literature cited here refers to multinational firms.

[24] Source: Forrester Research (2004), "Two-Speed Europe: Why 1 Million Jobs Will Move Offshore".

[25] Cited in OECD, 2005

that structural adjustments are underway, especially those induced by the EU enlargement process (Midelfart-Knarvik c.s., 2000) and the global trade liberalisation (Roach, 2003).

Recent empirical studies show that ICT manufacturing always was a bit concentrated, but since the early 1990s dispersion diminished concentration (Midelfart-Knarvik c.s., 2000). European ‘core’ countries such as, Germany, France, and UK have lost market shares in ICT world trade while Austria, Finland Ireland, and Sweden have won market share. This was explained in the previous sections. The ICT industries can be classified by their share of higher educated worker in the labour force (SKILL) and their (OECD defined) technology level (TECH), and by the existence a minimum efficient scale (ESCALE), industry linkages such as, use of intermediaries as share of the value of production (INTRA) and the use of intermediaries from other sectors as a share of production (INTER), their capital stock per employee (CAPI), and their growth in the value of gross production (GROWTH).

Table 19. Key Characteristics of ICT Manufacturing Industries

	SKILL	TECH	ESCALE	INTRA	INTER	CAPI	GROWTH
ISIC30	H	H	M	M	H	L	H
ISIC31	H	M	M	M	M	M	M
ISIC32	H	H	M	M	L	L	H
ISIC33	H	H	M	L	M	L	H

Source: Midelfart-Knarvik, 2000

H= High, M=Medium, L=Low

Skill= share of higher educated work force, TECH = OECD defined technology level, ESCALE= presence of economies of scale, INTRA intermediary deliveries as ratio of total use of inputs within the same industry, INTER= share of intermediary deliveries from other sectors, CAPI=capital intensity, GROWTH= growth of the value of production

Table 19 shows that all ICT manufacturing sectors that are employing highly educated people are high tech in nature (except ISIC31), but scale effects in production are not large. Because of the moderate minimum efficient scale, industrial linkages are most intensive for office, accounting and computing machinery (ISIC 30), and much less for medical, precision and optical instruments (ISIC 33), and/or for radio and television and communication equipment (ISIC 32). Growth of the value of gross production in all sectors is already quite high however, due to declining prices, the volume of production is even higher, especially in ISIC30 (see also Figure 10). Capital intensity is low in most of the ICT manufacturing sectors, with the exception of ISIC31. Table 19 clearly shows that skills of the labour force and proximity of supplying firms are very important requirements, while the scale of operation is not necessarily large. ICT producing firms are therefore highly dependent on skilled workers and proximate suppliers of intermediary goods and services and under these conditions, firms can relocate into these markets relative easily because of their low capital intensity.

4.1 What Has Happened to the Trade in ICT Goods?

The main characteristics of the developments in EU25 trade in ICT goods vis-à-vis the Rest of the World are visualised in Figure 29. In this figure the horizontal axis represents the difference between the price of exports and the price of imports of the same good, the vertical axis the difference between volume of exports and volume of imports. The idea is that when goods are homogenous and when markets are elastic the north-west and south-east quadrant will be populated by the bubbles representing a certain ICT good with respect to price and volume acres, and the size of the bubble represents the contribution (deficit or surplus) to the trade balance. We do not observe this expected pattern; on the contrary, the centre is densely populated with relatively small surpluses of EU25 while the outskirts are populated by the much larger trade deficits of EU25 in ICT goods trade.

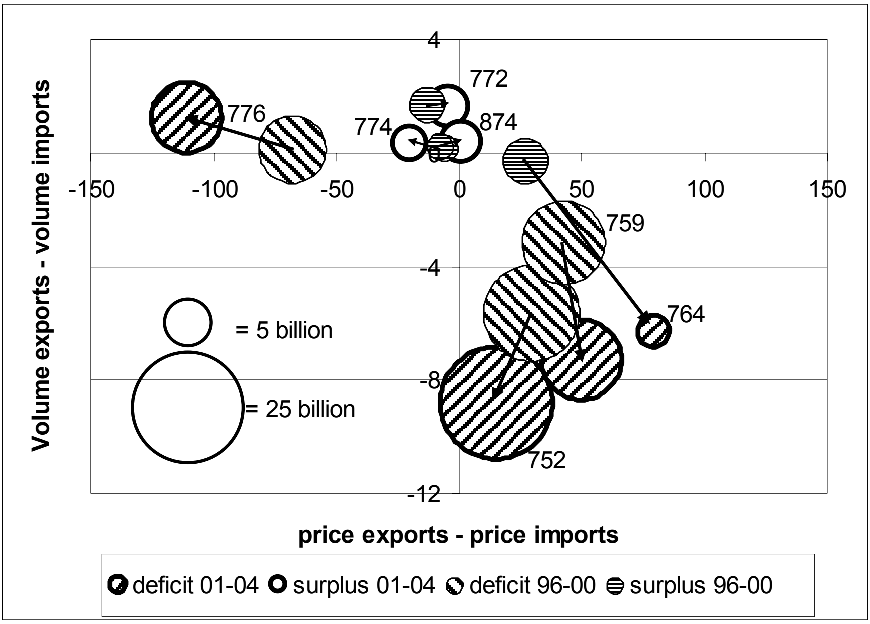


Fig. 29. Assignment of Shift in the Main Products Involved in Extra EU25 Trade in ICT Goods According to Price and Volume Differentials as well as the Contribution to the Trade Balance (shifts between averages of 1996-2000 and 2001-2004)

The open and horizontally shaded circles in Figure 29 represent the SITC product groups, electrical apparatus, etc. (SITC772), electrodiagnostic apparatus for medical, surgical, dental or veterinary purposes and radiological apparatus (SITC774) and measuring, checking analysing and controlling instruments etc

(SITC 874). The EU25 already has a surplus position in these groups which has even increased somewhat during the period under consideration: open circles represent a trade surplus in 2001-2004 while horizontal shaded circles also represent a trade surplus, now for the period 1996-2000. EU25's exports of electrical apparatus, etc. (SITC 772), and measuring, checking analysing and controlling instruments, etc. (SITC 874), became relatively more expensive while at the same time its trade surplus rose and its volumes barely changed. On the other hand, electrodiagnostic apparatus for medical, surgical, dental or veterinary purposes became relatively cheaper while trade surplus also rose. These two examples give a good impression of the position of EU25, which is mainly quality competition (as in the case of SITC 772 and 874), however, price competition is also a reality.

A comparison of the periods 1996-2000 and 2001-2004 represented in Figure 29, leads to the conclusion that the firmament became larger, in both prices and volumes. The expansion means that there was a larger difference in prices of exports and imports. This is the contribution of cathodes (SITC776), optical instruments and apparatus, n.e.s (SITC 871), due to parts and accessories for computers (SITC759) and telecommunications equipment (SITC 764). The trade surplus of the latter product group even turned into a trade deficit in the more recent years, due to a surge in the imported volumes of relatively cheap telecommunication equipment from abroad. Product categories with a trade deficit are diagonally shaded. Despite a relative price decrease in the exports of automatic data-processing machines and units thereof, etc. (SITC 752), imported volumes surged, leading to a slight increase in the trade deficit.

Our conclusion is that on the one hand EU25 ICT trade balance deficit is mainly caused by automatic data processing machines etc. (SITC 752), parts and accessories for computers (SITC759), and cathodes (SITC776), and in more recent years, telecommunication equipment. On the other hand, the EU25 holds a relatively strong position in electrical apparatus, etc. (SITC 772), electrodiagnostic apparatus for medical, surgical, dental or veterinary purposes, and radiological apparatus (SITC 774), and measuring, checking, analysing and controlling instruments and apparatus (SITC, 874).

Illustrative in this respect is EU25's trade in ICT goods vis-à-vis China, which differs from the trade with Japan especially with respect to prices. Average price (unit value[26]) of imports from China is 12 €/kg while EU 25's exports to China buys a price of 43 €/kg; EU25's imports from Japan are valued at 44.5 €/kg, while EU25's export to Japan are valued at 143.8 €/kg.[27] According to the theory two conclusions are possible: either EU25 exports consists of goods of higher quality compared to the imports of these goods, or EU25 exports as final goods and imports are components or intermediate goods to produce these exports. The latter interpretation implies an indirect confirmation of the central hypothesis of this study: the fragmentation of production of ICT goods. Therefore, competitiveness

[26] Defined as the value of the trade goods divided by their weight.

[27] Average of unit values in €/kg during 1993-2003.

has at least two dimensions, and quality as well as price competition plays a major role in ICT goods trade.

The assertion that ICT manufacturing needs on the average highly skilled labour (see Table 19) in Knarvik, 2003, is questionable given the wide variety of unit values for ICT manufactures. A more realistic assumption would be that ICT products come in various versions and that if a product grows older the knowledge intensity diminishes and less highly skilled labour are able to do the job. The huge and yearly increasing volumes that are imported each year by the EU25 from China in combination with the large difference in unit values reinforce this idea.

4.2 Stagnation of Inter EU25 Trade in ICT Goods Despite Enlargement

Despite the relative stagnation of inter EU25 trade in ICT goods, the global shift in global market shares has been considerable in recent years. China is clearly the big winner while US, UK and Japan are the losers with losses on all (import) markets. As a whole, EU25 won on all markets, mainly thanks to the European Tigers (Czech Republic, Hungary, Ireland and Poland). Therefore, the conclusion is that EU25 has a competitive edge especially in electrical apparatus (SITC 772) and in medical, precision and optical instruments (ISIC 33), and there are ample possibilities to enhance this advantage by intensifying R&D outlays in ICT goods producing enterprises, and by relaxation of national product market regulations.

4.3 What Has Happened to the Trade in ICT Services?

The performance and perspectives for ICT services are different from ICT goods. The service trade surplus of EU25 is surging at 20% per year (over the period 1993-2003). However, not every EU country gains from this trade; in fact, it is the specialisation of a few countries. Belgium, Ireland, Sweden, UK and the US are the countries specialised in the exports of computer and related services. ICT services embraces a rich variety including computer data and news-related service, transactions between residents and non-residents, data bases, data processing, and provision of processing services on a time-share or specific (hourly) basis. Management of facilities of others on a continuing basis; hardware consultancy; software implementation—including design, development, and programming of customized systems; maintenance and repair of computers and peripheral equipment; news agency services—including provision of news, photographs, and feature articles to the media; and direct, non-bulk subscriptions to newspapers and periodicals, are included in these services. Within this rich variety, some services are scale intensive like database services and news provision while others are scale extensive like software implementation; the same can be said on knowledge intensity. Consequently, there are large unleashed potentials for all countries in ICT services, because these services cover the whole range from scale and knowledge intensive to scale and knowledge extensive. Although the current levels of production are quite low, these services are surging in Poland, Czech Republic and also in France and Germany where higher levels of production exist. Much more is possible if these kinds of services become more liberalised and regulation becomes more harmonised in EU25. But this may take some time to materialise as it is well known that traditionally these locally provided services are subject to local regulation, which favours local provision and discourages standardisation, packaging and provision from elsewhere or abroad. Elimination of this locally inspired regulation will open up the possibilities to provide these services either from a local affiliation in a customised form, or from a distance using the possibilities to network when it comes to packaged services.

5 Conclusions

EU25's international trade position with respect to ICT goods vis-à-vis the Rest of the World, is characterised by a trade deficit of about ½% of GDP while the trade in services yields a growing trade surplus of ¼% of GDP. The ICT manufacturing sector is extremely exposed to the world market: ICT goods exports accounts for more than 50% of its GDP and imports of ICT goods account for more than 75%. The ICT services sector is less exposed: 20% of its GDP is exported and 10% imported. Does this mean that competitiveness of EU25 is low in ICT goods production and higher in ICT services? The answer is NO. The development for ICT goods is simply different from ICT services as the evidence over the period 1996-2004 indicates.

A key finding is that competitiveness has many dimensions and levels of quality, and price competition plays a major role in ICT goods production and trade. Many ICT products exported by the EU25 have much higher unit values than their imported counterparts. This does not apply to all ICT goods, but does especially to some subgroups within SITC 75 (parts for computers; SITC 759), SITC 76 telecommunication equipment (especially SITC 764 and SITC 87), products optical instruments (SITC 871) and optical goods (SITC 884).

Before discussing the findings with respect to trade in ICT goods and services, we would like to stress the following rather remarkable point: inter EU trade in ICT goods did not increase very much, at least in a relative sense. Despite the enlargement of EU15 into EU25, inter EU25 trade in office, accounting and computing machinery computers (ISIC30) in 1993 was 46% of total imports and 47% in 2003. Inter EU25 trade in radio and television and communication equipment (ISIC32) even diminished, while inter-EU25 trade in medical, precision and optical instruments (ISIC33) rose from 50% in 1993 to 52% in 2003. Economic integration did not materialise in ICT goods production, and the new member states found more new markets outside the EU25 than inside.

Recently there has been a considerable shift in global market shares of ICT goods. China is clearly the big winner, while the US, UK and Japan are the losers who have lost on all markets. EU25 as a whole won on all markets mainly thanks to the European Tigers (Czech Republic, Hungary, Ireland and Poland). Therefore, the conclusion is that EU25 has a competitive edge especially in ISIC 33, and there are ample possibilities to enhance this advantage by intensifying R&D outlays in ICT goods producing enterprises, and by relaxation of national product market regulations.

EU25's trade position with the Rest of the World is an aggregate picture that can be quite different for individual countries as is shown in the tables of the trade position of Germany, France, the Netherlands and UK. From these tables, it becomes clear that each of the four countries has its own strong features, not only with respect to quality competition, but also with respect to price competition. In this respect, the position of the Netherlands and Germany suggest that RTA supports RCA. This also implies that knowledge drives not only quality competition but also price competition.

The perspectives for ICT services are different from those for ICT goods. The trade surplus of EU25 is growing at a pace of almost 20% per year (over the period 1993-2003). However, not every EU country gains from these trade improvements; in fact it is the specialisation of a few countries, especially Ireland, UK, and the US, which are specialised in the export of computer and related services (ISIC 72). It is within this area that there are large unleashed potentials for other countries too, especially for Poland, Czech Republic, France and Germany, which have exhibited high growth rates in more recent years.

Although the sectors investigated in this section are still heterogeneous in terms of product characteristics, a general pattern emerges from all analysis presented in this chapter. Sectors in which the quality of products is relatively higher, the sectors which produce goods with relatively high unit values, i.e. medical and optical instruments (ISIC 33) and computer and related services (ISIC72), in general show a more stable position with respect to the trade balance and net volumes sold to the global market, showing at the same time a strong and improving comparative advantage. In general, these conclusions seem to be consistent with some of the theoretical views as presented in Chapter II, such as internationalisation of services which is still in its infancy. Nevertheless, we were introduced to some unsolved problems related to the role of value added per hour as a determinant for strong RCA positions. Japan is the most productive economy as far as ICT production is concerned, but its RCA position becomes weaker and weaker. On the contrary, the European Tiger countries have low productivity while their RCA position grows stronger and stronger.

CHAPTER IV. Trends in Foreign Direct Investment

Andre Jungmittag

1 Introduction

From a theoretical point of view, firms generally have three possibilities to supply foreign markets with goods and services: exports, foreign direct investment (FDI) and licensing. According to the OLI paradigm introduced by Dunning (1977), a firm will engage in FDI if ownership, locational and internalisation advantages coincide. Particularly, FDI is the first choice of means to supply a foreign market with services, which are often considered as non-tradable goods. In this case, FDI can replace the exports that are not possible because of the necessary double coincidence, which means that transactions of services in most cases require the spatial and temporal proximity of buyers and sellers simultaneously. For principally tradable goods, there can be trade barriers or high transport costs (generally spoken: very high transaction costs that discourage exports) which prompt firms to substitute exports by FDI. On the other hand, a complementary relationship can also exist between FDI and exports. [1] Thus subsidiaries can be established abroad that provide direct contacts with the customers and additional services while the digitalized basic services, such as databases or software, can be provided by the firm headquarters. Furthermore, FDI can be a driving force of the fragmentation of production, which means the splitting-up of the value added chain allowing for a more in-depth specialisation. The reason therefore is that different stages of production correspond to different production functions so that a country may have a comparative advantage in one stage of production and a comparative disadvantage in other stages. Today, the ICT industry has one of the most globally fragmented productions in the manufacturing sector.

Furthermore, in the modern literature on the motives and effects of FDI we find the differentiation between horizontal and vertical FDI (cf. Nunnenkamp, 2006). The notion of horizontal FDI is closely linked to the substitional type of FDI and means that firms produce the same goods and services in their home country and in the host countries, which is – as already mentioned – often motivated by high transaction costs. Since this type of FDI is often driven by market consideration, it is also labelled as market-seeking FDI. Vertical FDI, on the other hand, is a means

[1] A comprehensive presentation of the different theoretical approaches to explain substitutional and complementary relationships between FDI and exports can be found in Jungmittag (1996), pp. 44 – 133.

of geographical production fragmentation. Since this FDI is driven by cost consideration, it is often labelled as efficiency-seeking FDI.

When we come from the theoretical to the empirical analysis of the internationalisation of ICT activities, of course we cannot differentiate solely from a view on the data between these different types of FDI, derived from economic theory. However, our classification of ICT related economic activities in two dimensions, knowledge intensity and the importance of scale, derived in the theoretical part of the project, can help us to narrow down the motives and effects of the FDI of the different ICT producing and using sectors.

In the following, we will consider the development of the outward and inward FDI stocks of the European ICT sectors between 1994 and 2003. Additionally, for the ICT services we will present some results from the statistics of foreign affiliates' total sales and employment (FATS), which just has been published by Eurostat. However, with regard to the empirical analysis of the outward and inward FDI stocks of the European ICT sectors as well as for the FATS data, it has to be mentioned first of all, that the FDI statistics of Eurostat have more holes per cubic metre than a Swiss cheese. Altogether, we will use the available data for the following ICT sectors:

- Office, accounting & computing machinery (ISIC 30),
- Radio and television & communication equipment (ISIC 32),
- Telecommunication (ISIC 6420),
- Computer & related services (ISIC 72),
- Research and Development (ISIC 73),
- Business Services n.e.c. (ISIC 74).

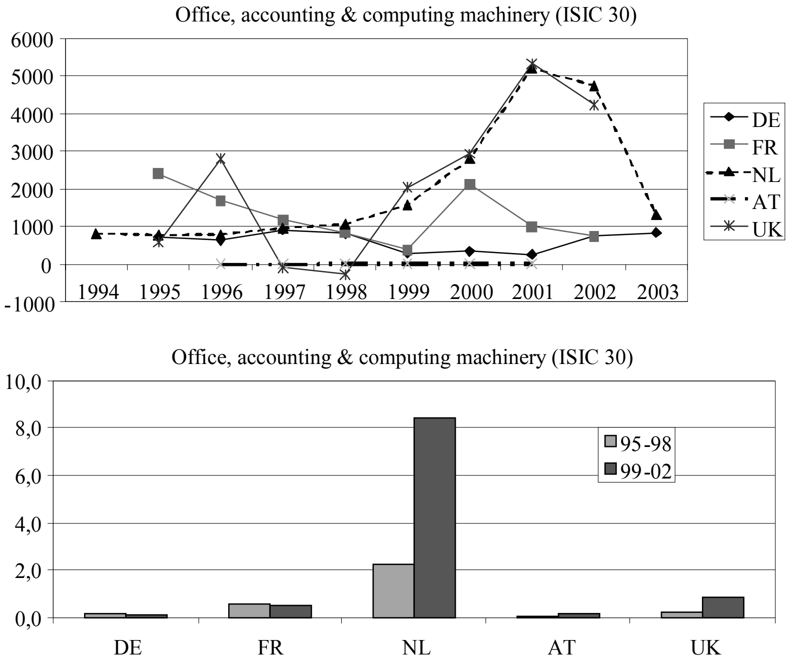
While the first two sectors belong to the manufacturing industries, the remaining sectors belong to the service industries. With regard to the number of EU countries taken into account, we have outward FDI stock data for five countries – Austria, France, Germany, the Netherlands and the United Kingdom, which cover more or less the whole time span under consideration. Inward FDI stock data is additionally available for Portugal. Furthermore, FATS data is available for Belgium, Czech Republic, Germany, Greece, Austria, Portugal, Finland and Sweden. However, we can only analyse the employment data, because total production data, which is needed to calculate ratios, is not available in the OECD STAN database for some countries and sectors considered.

This analysis is divided into two parts, one for the outward and one for the inward FDI stocks, and at the end of each part, on the one hand, we undertake a variance analysis by means of a regression model with dummy variables to identify the effects explaining the degree of internationalisation by FDI, and, on the other hand, since the interaction effects between countries and sectors are particularly important, we make our classification of ICT related economic activities in two dimensions feasible by approximating knowledge intensity by country and sector specific R&D-intensity as well as importance of scale by employment per enterprise, and assign the sectors of those countries, for which the necessary data is available, to the four fields of our classification: innovative scale sectors, innovative niche sectors, traditional niche sectors and traditional scale sectors. Finally, some conclusions will be drawn from our empirical findings.

2 Outward FDI Stocks

2.1 Office, Accounting & Computing Machinery (ISIC 30)

The first panel in Fig. 30 displays the absolute outward FDI stocks in million Euros in the sector “office, accounting & computing machinery”. It is obvious that the Netherlands and the UK realised a strong parallel increase in their stocks from 1998 to 2001, which brought them to leading positions within the group of countries considered and probably the whole EU. The FDI stocks of both countries fell a little bit from 2001 to 2002. Additionally, the stock of the Netherlands reduced strongly within the next year, so that they nearly reached the position of Germany, while no data is available for the UK. With the exception of an outlier in 2000, we can observe for France a more or less parallel development to Germany from 1997 to 2002, while the FDI stock of Austria is microscopic in this sector.



Source: Eurostat, GGDC, own calculations

Fig. 30. Absolute Outward FDI Stocks and FDI/VA-Ratios: Office, Accounting & Computing Machinery

The second panel in Fig. 30 shows the ratios of outward FDI stocks to value added in the sector “office, accounting & computing machinery” for the two periods 1995 to 1998 and 1999 to 2002. The Netherlands also dominates in a relative view the situation within our group of countries and probably in the whole EU. The United Kingdom has clearly improved its relative position from the first to the second period, but is far away from the Netherlands, while France and Germany have slightly lost ground. Again, the FDI stocks of Austria in this sector play no role.

2.2 Radio and Television & Communication eEquipment (ISIC 32)

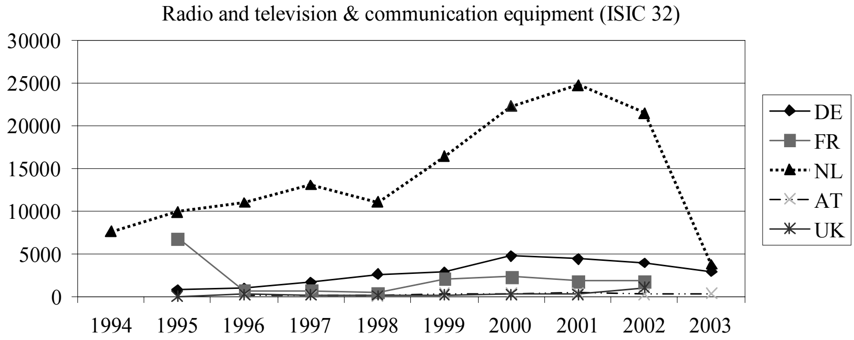
Generally, the absolute FDI stocks in the sector “radio and television & communication equipment” are higher than in the sector “office, accounting & computing machinery” (panel 1 in Fig. 31). Nearly over the whole period considered, namely from 1995 to 2002, the absolute FDI stock of the Netherlands in this sector dominates the stocks of the other four countries, while Germany is second. However, in 2003 the FDI stock of the Netherlands drops significantly to the level of Germany. France takes the third position in this sector, while – differently from their FDI stock in the sector “office, accounting & computing machinery” – the UK plays on the fourth position no great role. Again, the FDI stock of Austria is minuscule.

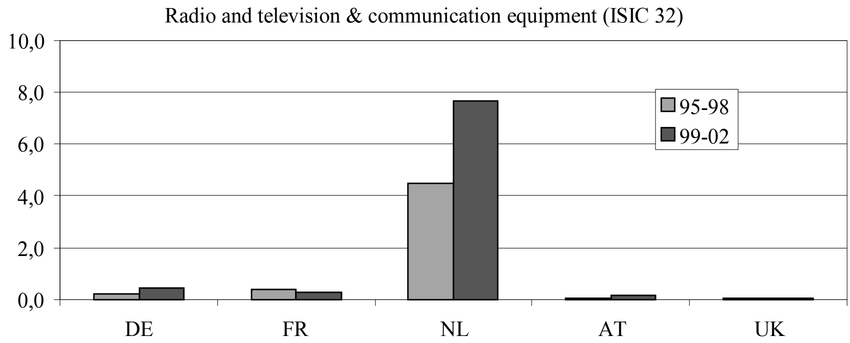
From a relative point of view (panel 2 in Fig. 31), the Netherlands are also dominant in this sector. Between France and Germany we can observe a change of the roles between the first period from 1995 to 1998 and the second period from 1999 to 2002. While France was second in the first period, it is Germany in the second period. Actually, France is the only country of the five considered, which lost ground from the first to the second period. The FDI-stock-to-value-added-ratios of Austria and the UK are only infinitesimal.

2.3 Telecommunications (ISIC 6420)

At the beginning of the 21st century, the FDI stock of the UK in the telecommunications sector is the highest of all EU outward FDI stocks in the area of ICT, only very nearly reached by the German FDI stock in sector “business services n.e.c.” (cf. the first panels of Fig. 32 and Fig. 38). With a sole view to the telecommunications sector Germany also achieved a rather high outward FDI stock in 2001 and 2002, but only about a fifth of that of the UK. The other three countries considered only have comparatively small outward FDI stocks.

With regard to the relative positions the UK is clearly leading, but reaches in the second period only the half of the ratio of the Netherlands in the sectors considered previously. This might be partly due to the fact that the used value added data published by the GGDC includes the whole communications sector. Nevertheless the UK increased their ratio dramatically from the first to the second period (the second panel in Fig. 32). Mentioned in the order of magnitude, the



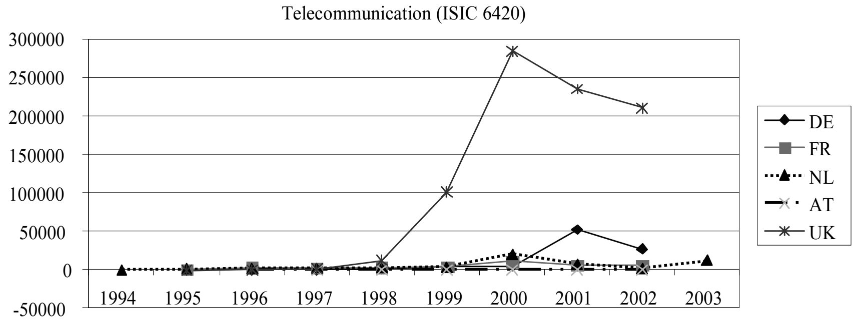


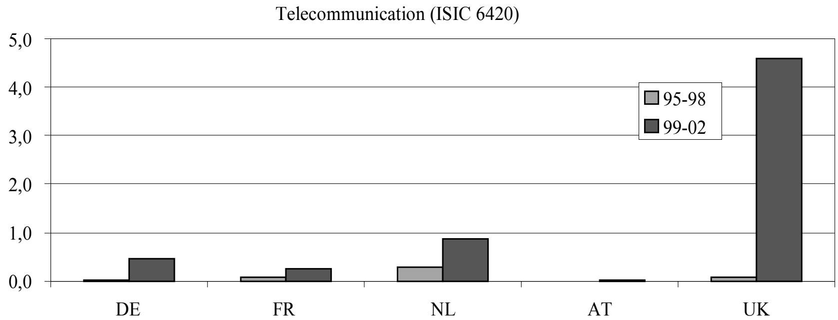
Source: Eurostat, GGDC, own calculations

Fig. 31. Absolute Outward FDI Stocks and FDI/VA-Ratios: Radio and Television & Communication Equipment

Netherlands, Germany and France also realised noteworthy increases of their ratios, while the ratios of Austria are negligible in both periods.

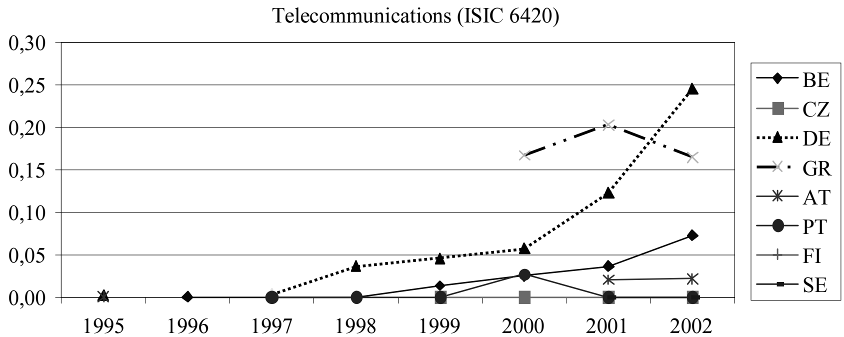
As already mentioned in the introduction, also the foreign affiliates' employment data is available for the service sectors, but only partly for eight other countries. The ratios of foreign affiliates' employment to domestic employment are displayed in Fig. 33. Within the group of EU countries considered now, Germany realised the most dramatic increase of its employment ratio from almost zero in 1997 to 0.05 in 2000 and then almost 0.25 in 2002. Only Greece, for which data is only available from 2000 to 2002 shows an almost similar high foreign affiliates' employment ratio, namely approximately 0.17 in 2000 as well as 2002, and 0.20 in 2001. Furthermore, Belgium increased this ratio considerably from 1998 to 2002. The ratios of the other EU countries considered are negligible.





Source: Eurostat, GGDC, own calculations

Fig. 32. Absolute Outward FDI Stocks and FDI/VA-Ratios: Telecommunications



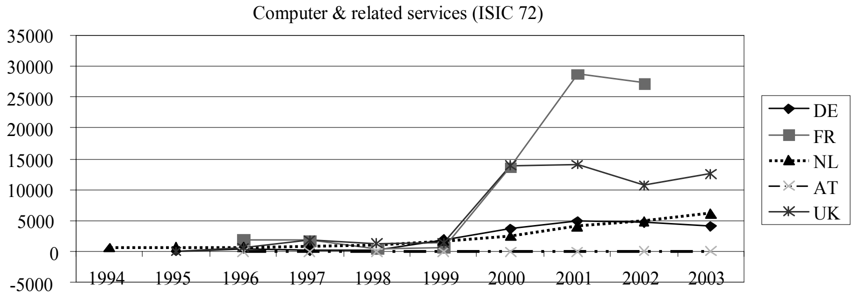
Source: Eurostat, GGDC, own calculations

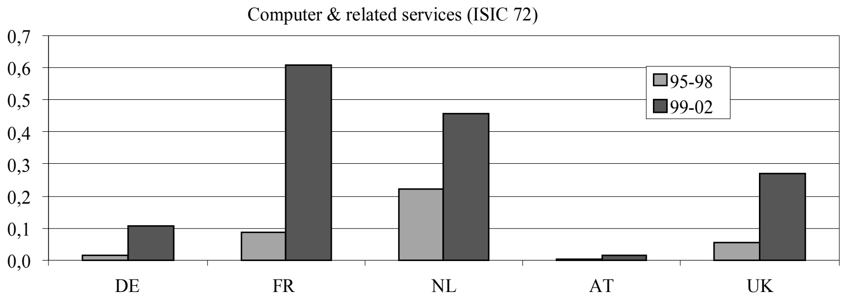
Fig. 33. Foreign Affiliates Employment/Domestic Employment Ratios: Telecommunications

2.4 Computer & Related Services (ISIC 72)

In the sector "computer and related services" France clearly plays first since the end of the nineties, both from an absolute as well as from a relative point of view (cf. Fig. 34). From a relative point of view it has passed the Netherlands from the second half of the nineties to the period from 1999 to 2002. In absolute numbers, the UK follows the trace of France until 2000, but remains then on the level reached. Furthermore, with regard to the absolute outward FDI stocks, Germany and the Netherlands move more or less side by side during the whole period considered. Finally, the absolute FDI stocks as well as the FDI-to-value-added ratios for Austria are negligible. Altogether, it has to be mentioned, that the degree of internationalisation, measured by these ratios, is much lower in the sector "computer and related services" than in the sectors considered previously.

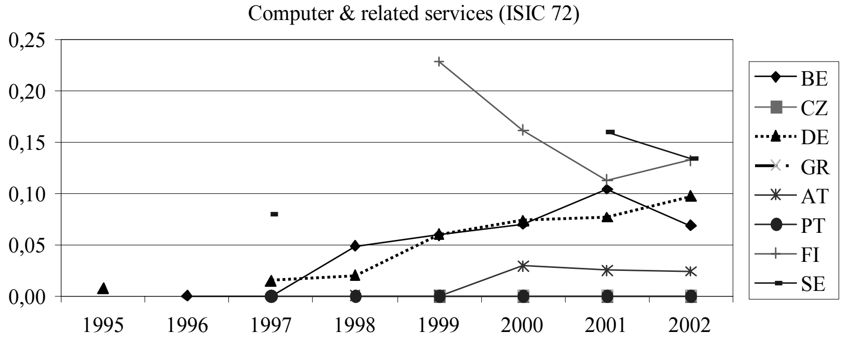
With regard to the foreign-affiliates-employment-to-domestic-employment ratios Finland shows with its first available data point in 1999 a rather high degree of internationalisation in the sector "computer and related services", which, however, reduces until 2002 to a nearly normal ratio within in the group of countries which can be considered now (cf. Fig. 35). Sweden shows in 2002 a similar degree of internationalisation, measured by this ratio, followed by Germany and Belgium. Furthermore, Austria shows since 2000 a small tendency towards internationalisation in this sector, while this is not the case for Portugal.





Source: Eurostat, GGDC, own calculations

Fig. 34. Absolute Outward FDI Stocks and FDI/VA-Ratios: Computer & Related Services



Source: Eurostat, GGDC, own calculations

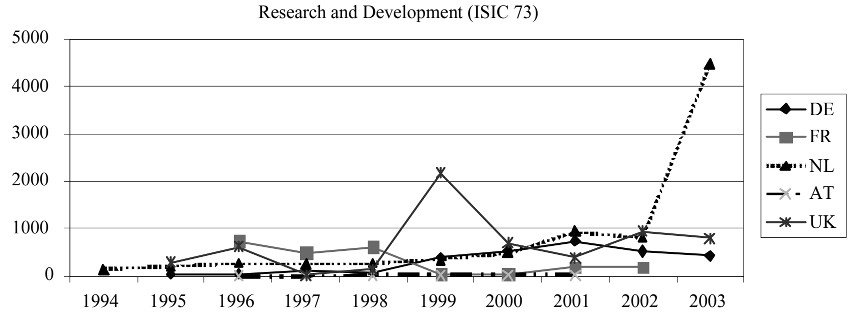
Fig. 35. Foreign Affiliates Employment/Domestic Employment Ratios: Computer & Related Services

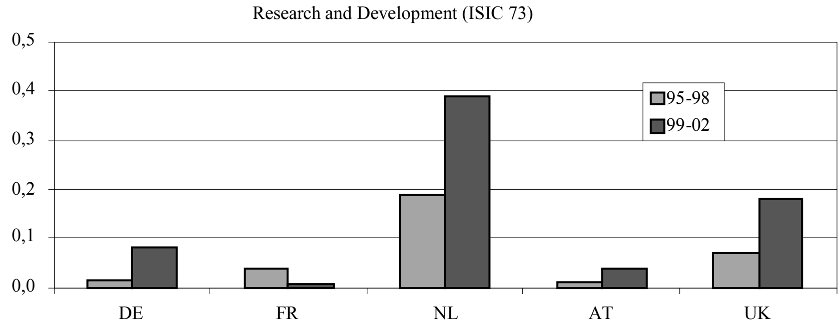
2.5 Research and Development (ISIC 73)

The service sector "research and development" is by far the sector with the lowest absolute and relative numbers of outward FDI activities (cf. Fig. 36). In absolute numbers the Netherlands take the first place in 2003, followed by the UK and Germany. Over the whole period under consideration, these three countries moved – more or less – on the same level, while the activities of France clearly fall between 1998 and 1999 below this level. Again, the activities of Austria are marginal.

This drop of France's FDI activities is also obvious in the relative numbers (cf. the second panel of Fig. 36). Furthermore, the Netherlands have in both periods considered the highest relative FDI stocks, again followed by the UK and Germany. Austria reached, at least in the second period from 1999 to 2002 a higher relative level than France.

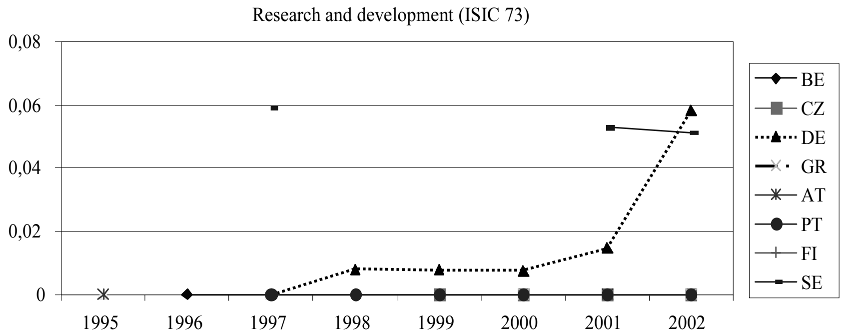
A glance on the foreign-affiliates-employment-to-domestic-employment ratios shows that these numbers are also comparatively small. From 1997 to 1998 a small increase can be observed for Germany, and a further stronger increase from 2001 to 2002, where Germany passed Sweden. The ratios of the other small countries in this data set are microscopic.





Source: Eurostat, GGDC, own calculations

Fig. 36. Absolute Outward FDI Stocks and FDI/VA-Ratios: Research and Development



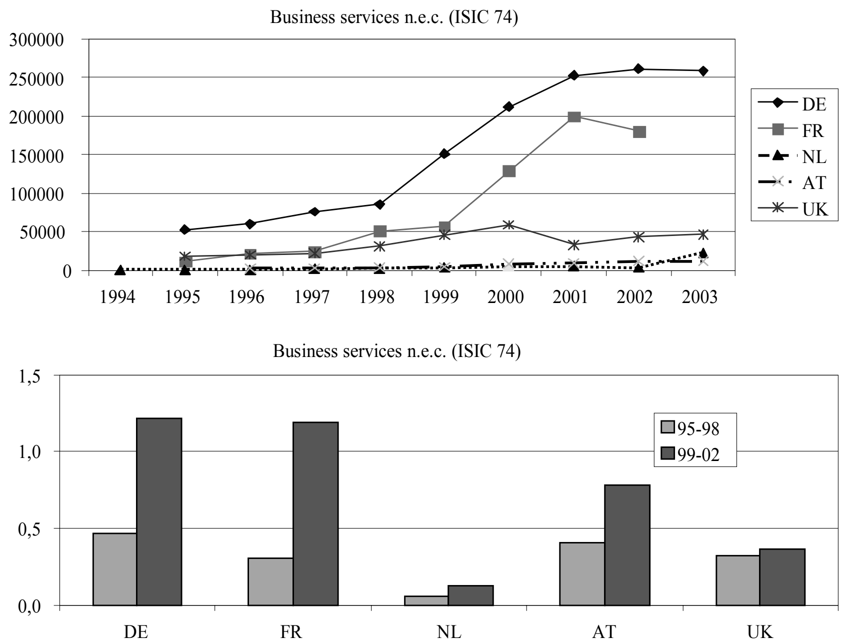
Source: Eurostat, GGDC, own calculations

Fig. 37. Foreign Affiliates Employment/Domestic Employment Ratios: Research and Development

2.6 Business Services n.e.c. (ISIC 74)

The “business services n.e.c.” are besides “telecommunications” the sector with the highest absolute outward FDI stocks (cf. the first panel in Fig. 38). Over the whole period Germany is clearly leading. It experienced a drastic increase of its outward FDI stock from 1998 to 2001 where it seems to have reached a new longer lasting level. The outward FDI stock of France moved on a lower level nearly parallel to that of Germany, but shows from 2001 to 2002 a small slump. The UK takes place three in this sector, but its outward FDI stock did not follow the drastic increase of those of the two formerly mentioned countries. Finally, Austria and the Netherlands moved – more or less – on the same low level.

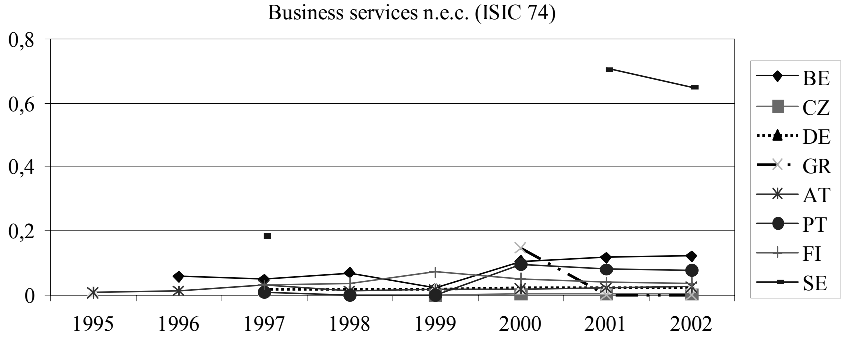
The leading absolute positions of Germany and France are also reflected in the FDI-to-value-added-ratios, where these two countries take place one and two in the second period. Actually, the relative position of France in the first period was only number four, so that it shows a clear leapfrogging process, while Germany was already in the first period leading, however not with such a large distance to the other countries. Astonishingly Austria has a rather strong relative position in this area, while the UK are in both periods number four. Furthermore astonishingly, the Netherlands have only a rather weak position in this sector, while they are in most other sectors leading.



Source: Eurostat, GGDC, own calculations

Fig. 38. Absolute Outward FDI Stocks and FDI/VA-Ratios: Business Services n.e.c.

A view on the foreign-affiliates-employment-to-domestic-employment ratios shows that Sweden has very high ratios in 2001 and 2002, while its ratio was in 1997, where another datapoint is available for this country, only moderately above those of the other countries now considered (cf. Fig. 39). Furthermore, Belgium and Portugal have rather high employment ratios, at least since 2000, while the ratios of Germany are rather small, compared with those of the small countries in this data set.



Source: Eurostat, GGDC, own calculations

Fig. 39. Foreign Affiliates Employment/Domestic Employment Ratios: Business Services n.e.c.

2.7 Effects Explaining Outward FDI-to-Value-Added-Ratios

In order to identify the determinants of the differences between the outward FDI-to-value-added ratios between the five countries, six sectors and two periods we undertook a variance analysis with three factors (country, sector and time effects) and interaction effects between countries and sectors by means of a regression model with dummy variables. Concretely, the basic version of the estimated model is

$$\ln\ FDI_{ijt} = \alpha + \beta_i + \gamma_j + \tau_t + \delta_{ij} + u_{ijt},$$

where β_i, γ_j and τ_t are the country, sector and time effects. Furthermore, δ_{ij} are the interaction effects.

Altogether, the model explains 89.72 percent of the variation of the logs of the outward FDI-to-value-added ratios (Table 20). The time effect is clearly statistically significant at a level below 1 percent and explains roughly ten percent of the variation in the data. There is no doubt, that there is generally an increase of the outward FDI-to-value-added ratios from the first to the second period: all other things equal the ratios in the second period are on average double as high than in the first period. Secondly, the country effects explain 10 percent of the variation and are statistically highly significant. However, a closer inspection of the estimation results reveals that this effect is mainly carried by the Netherlands (cf. Table

37, in Appendix C). They have generally higher outward FDI ratios than the other countries. Thirdly, the sector effects are also statistically significant, meaning that there are sectors – over all five countries – which have especially high or low outward FDI ratios. More concretely, the sector "research and development" has on average lower outward FDI ratios than the first sector "office, accounting & computing machinery", while the sector "business services n.e.c." has on average higher outward FDI ratios.

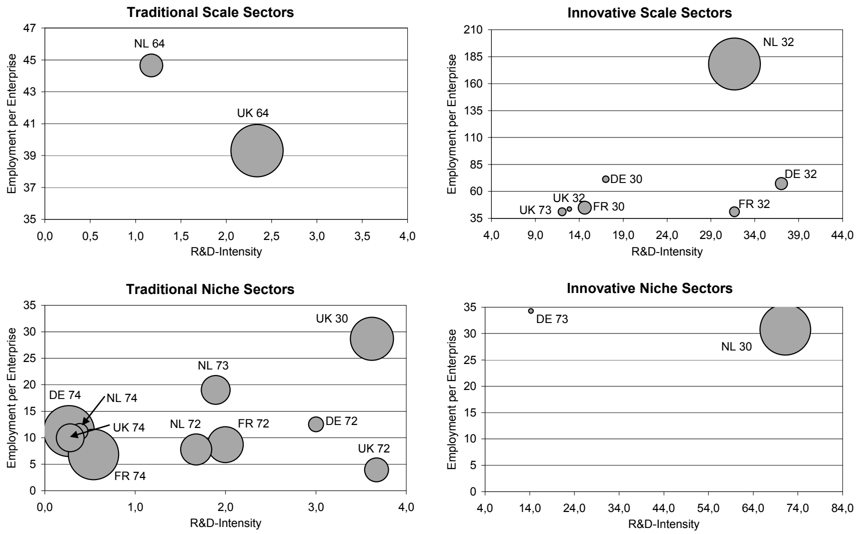
Table 20. Variance Analysis for the Outward FDI/VA-Ratios

Source	Partial sums of squares		Degrees of	Mean unbiased	F-value	Signifi-
	Absolute	In percent	freedom	sum of squares		cance level
Model	149.87	89.72	30	5.00	8.15	0.000
Time effect	16.13	9.66	1	16.13	26.32	0.000
Country effects	16.90	10.12	4	4.23	6.89	0.001
Sector effects	14.83	8.88	5	2.97	4.84	0.003
Interaction effects	57.63	34.50	20	2.88	4.70	0.000
FR x sector	4.32	2.59	5	0.86	1.41	0.251
NL x sector	19.81	11.86	5	3.96	6.46	0.000
AT x sector	2.13	1.28	5	0.43	0.70	0.631
UK x sector	12.09	7.24	5	2.42	3.95	0.008
Residual	17.17	10.28	28	0.61		
Total	167.04	100.00	58			

Finally the interaction effects between countries and sectors explain roughly 35 percent of the total variation in the data, but a closer inspection of the estimation results shows again, that actually only the interaction effects between the Netherlands and the sectors as well as between the UK and the sectors are statistically significant. This result means, that there are some sectors, in which the Netherlands and the UK are particularly strong or weak. Thus, altogether our findings show that a simple model taking into account cuntry, sector, time effects and – rather important – interaction effects between countries and sectors can explain a large amount of the variation of outward FDI-to-value-added ratios within our group of EU countries.

Since the interaction effects play an important role in explaining the FDI-to-value-added ratios, which might be due to the fact that the knowledge intensity and the impact of scale effects might be of different importance for the individual country-sector-combinations, we assign as a final step the sectors for the individual countries and the second period from 1999 to 2002 to our classification in two dimensions, knowledge intensity and the importance of scale. Since sector R&D intensity, which we used as an approximation for knowledge intensity, is not available for Austria at all as well as for telecommunications for Germany and France and for the sector "research and development" for France, we dropped these observations. The assignment of the remaining sector-country-combinations is shown in Fig. 40. Thereby the size of the bubbles symbolized the relative amount of the outward FDI stocks to value added ratios within one field of our classification, meaning that the sizes cannot be compared between the fields. Furthermore, we assumed that country-sector-combinations with an R&D-intensity above 4 percent are knowledge-intensive, and that more than 35 persons employed per enterprise indicates importance of scale.

In the field for innovative scale sectors we find the sector "office, accounting and computing machinery" for France and the Netherlands, the sector "radio, television & communication equipment for all four countries as well as the sector "research and development" for the UK, which, however, is very close to the same sector of Germany that is assigned to the field for innovative niche sectors because of it's a little bit lower average enterprise size. Here, we also find the computer machinery sector of the Netherlands. The same sector of the UK is the only manufacturing sector in the field for traditional niche sectors. The other sectors in this field are computer & related services as well as business services n.e.c. for all four countries as well as "research and development" for the UK. To the last field of traditional scale sectors only the telecommunications sectors of the Netherlands and the UK can be assigned.



Source: Eurostat, GGDC, OECD Anberd, own calculations

Fig. 40. Assignment of ICT Related Sectors According to Knowledge Intensity as well as Importance of Scale and Outward FDI Stocks to Value Added Ratios

The other way around, it can be shown that importance of scale and knowledge intensity of the domestic ICT sectors have an impact on the respective outward FDI stocks. Corresponding regression results are presented in Table 21, where importance of scale is measured, on the one hand, by employment per enterprise (EMPEN), and, on the other hand, by value added per enterprise (VAPEN). Knowledge intensity is again approximated by the R&D-intensity (RDINT), and the dependent variable is the outward FDI-to-value-added ratio in the second period from 1999 to 2002.

Table 21. Regression Analysis of the Outward FDI/VA Ratios

Variable	Model I	Model II
EMPEN	0.041	---
	(3.345)[a]	
VAPEN	---	0.852
		(1.815)
RDINT	0.120	0.138
	(4.572)	(4.282)
Likelihood-ratio tests		
Country effects χ^2	7.273	8.303
	(0.064)[b]	(0.040)
Sector effects χ^2	16.403	12.719
	(0.006)	(0.026)
R^2	0.815	0.646
Adj. R^2	0.629	0.455

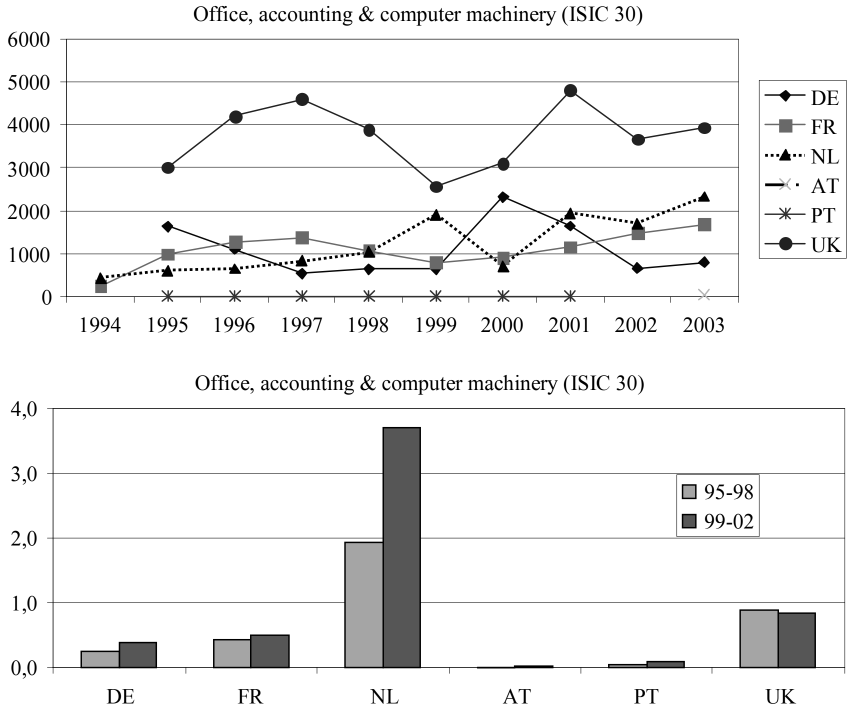
[a] t-values in parentheses. White heteroskedasticity-consistent standard errors are used to calculate these statistics.
[b] Significance levels in parentheses.

It is obvious from Table 21 that both knowledge intensity and importance of scale have a statistically highly significant positive impact on the outward FDI-to-value-added ratios. Model II shows thereby a better goodness of fit caused by the higher explanatory power of employment per enterprise compared to value added per enterprise. Furthermore, country effects as well as sector effects are again statistically highly significant. Thus, the models give evidence for one part of the Dunning explanation of FDI, namely that ownership related advantages are needed to undertake FDI, due either to the high knowledge intensity or to economies of scale, or due to both.

3 Inward FDI Stocks

3.1 Office, Accounting & Computing Machinery (ISIC 30)

With regard to the absolute inward FDI stocks in the sector “office, accounting & computing machinery”, the UK is leading – as well as with regard to the absolute outward FDI stocks in this sector (panel 1 in Fig. 41). Second are again the Netherlands, however now with a clearly larger distance than in the case of outward FDI stocks. France and Germany move approximately on the same level like the Netherlands. Finally, the inward FDI stocks of Austria and Portugal in this sector are marginal.



Source: Eurostat, GGDC, own calculations

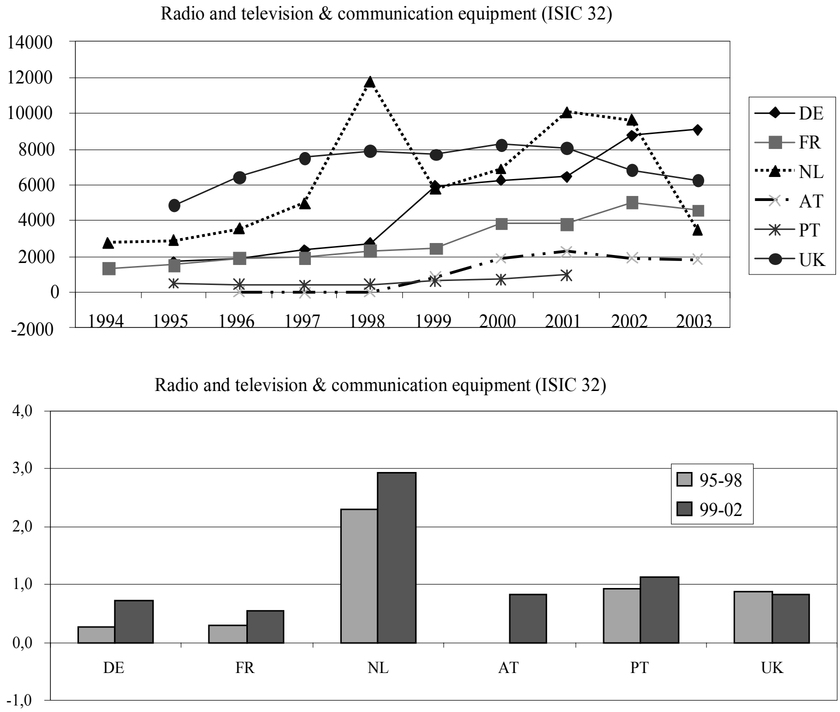
Fig. 41. Absolute Inward FDI Stocks and FDI/VA-Ratios: Office, Accounting & Computing Machinery

The second panel in Fig. 41 now shows the ratios of inward FDI stocks to value added in the sector "office, accounting & Computing machinery" for the two periods 1995 to 1998 and 1999 to 2002. Obviously, the Netherlands doubled their inward FDI ratio from the first to the second period and have in both periods the highest relative inward FDI stock. The UK is second, but experienced a small reduction of their ratio from the first to the second period. Furthermore, the ratios of Germany and France are clearly smaller, and those of Austria and Portugal are microscopic.

3.2 Radio and Television & Communication Equipment (ISIC 32)

In the sector "radio and television & communication equipment" Germany acquired the first absolute position during the end of the nineties and the beginning of the 21st century (cf. the first panel in Fig. 42). On the other hand, the UK lost ground since 2001 and is now on the second position. The development of France was parallel to the development of Germany, but on a lower level. The inward FDI stock of the Netherlands moved rather erratic with a peak in 1998 and a drastic slump in 2003, so that the Netherlands are now on the fourth position. Furthermore, the FDI stock of Austria has gained momentum at the end of the nineties, while the inward stock of Portugal remains rather low.

From a relative point of view the picture looks a little bit different (cf. the second panel in Fig. 42). Again, the Netherlands have in both periods the highest inward FDI-stock-to-value-added ratio, followed by Portugal and the UK. Austria has reached the fourth position in the second period, while its ratio was microscopic in the first period. The last two positions are taken by Germany and France.



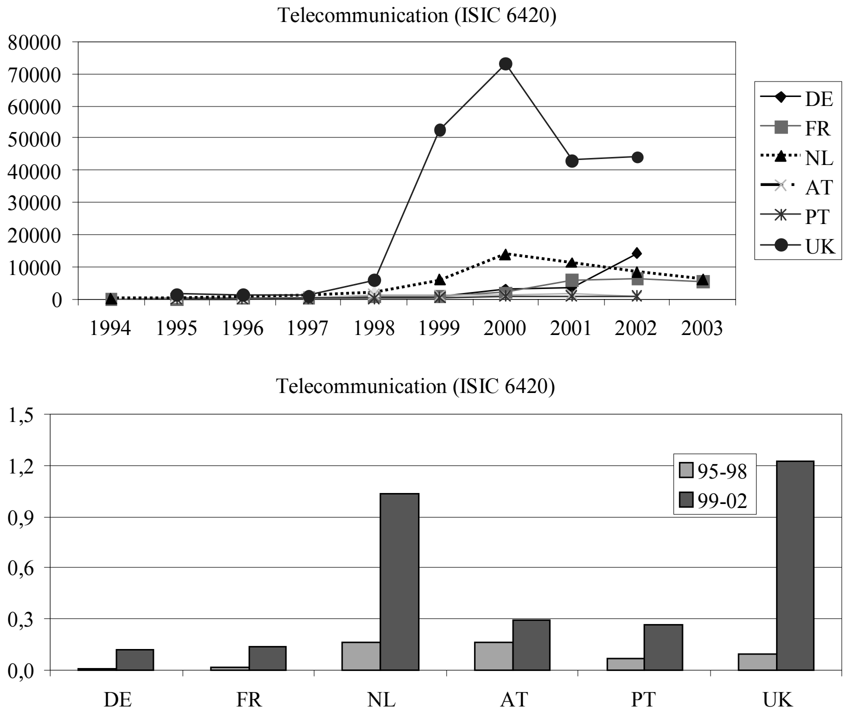
Source: Eurostat, GGDC, own calculations

Fig. 42. Absolute Inward FDI Stocks and FDI/VA-Ratios: Radio and Television & Communication Equipment

3.3 Telecommunications (ISIC 6420)

The inward FDI stock of the UK in the sector “telecommunications” increased drastically from 1998 to 2000 (Fig. 43). Thereafter, we observe a moderate reduction and then a stagnation. Furthermore, Germany passed the Netherlands in 2002, which are now on the same level as France. Again, the inward FDI stocks of Austria and Portugal are marginal in absolute numbers.

The second panel of Fig. 44 shows that all countries considered increased their inward FDI-stock-to-value-added ratios considerably. The highest increases could be observed for the UK and the Netherlands, followed by Austria and Portugal. On the other hand, the ratios of France and Germany were very low in the first period and remain rather low in the second period.



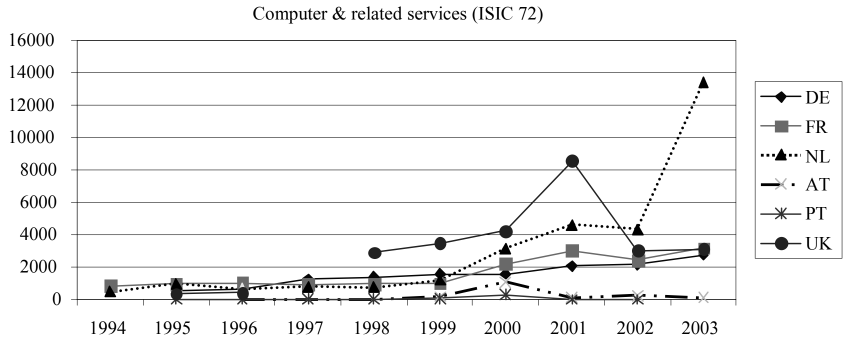
Source: Eurostat, GGDC, own calculations

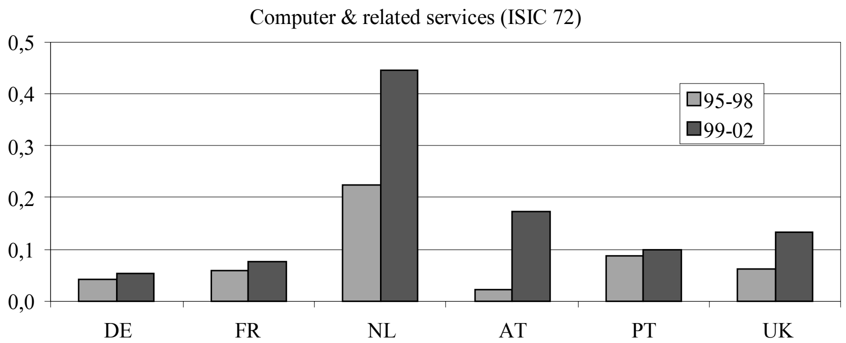
Fig. 43. Absolute Inward FDI Stocks and FDI/VA-Ratios: Telecommunications

3.4 Computer & Related Services (ISIC 72)

In the sector “computer & related services”, the Netherlands more than tripled their absolute inward FDI stock from 2002 to 2003 and have now by far the leading position (the first panel of 44). On the other hand, the UK falls back and reached in 2003 the same level as Germany and France. With regard to Austria and Portugal we only can repeat us: their inward FDI stocks are marginal.

The picture changes a little bit when the relative numbers are considered (the second panel of 44). Clearly, the Netherlands are leading, but in the second period Austria takes the second position and Portugal has the second position in the first period and the fourth in the second period. The UK has the third position in the second period, while France and Germany bring up the rear.





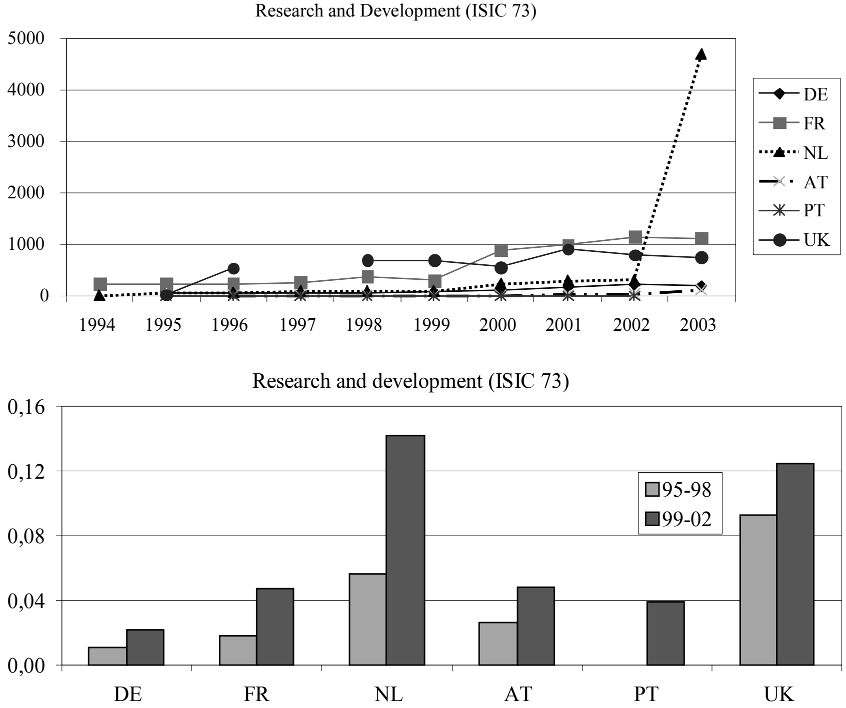
Source: Eurostat, GGDC, own calculations

Fig. 44. Absolute Inward FDI Stocks and FDI/VA-Ratios: Computer & Related Services

3.5 Research and Development (ISIC 73)

With regard to the absolute inward FDI stocks in the sector “research and development” the Netherlands have catapulted themselves from a low position in 2002 to the leading position in 2003 (the first panel in Fig. 45). France and the UK take the places two and three, while the absolute inward FDI stocks of Germany, Austria and Portugal are comparatively low.

From a relative point of view, the Netherlands were only second after the UK in the first period considered, but clearly number one in front of the UK in the second period (panel 2 in Fig. 45). Furthermore, Austria and France reached nearly the same ratio in the second period, followed by Portugal and finally Germany.



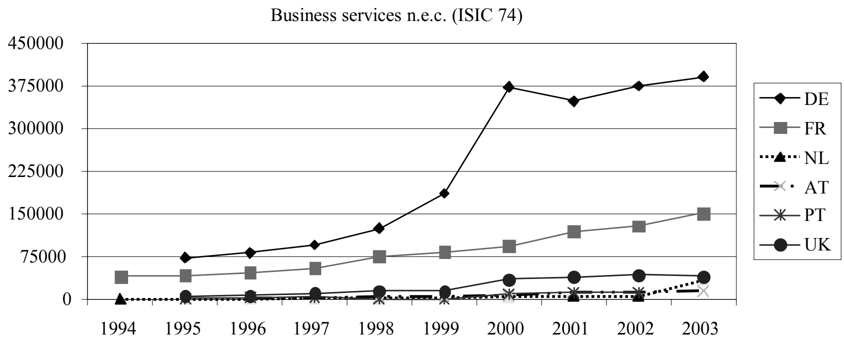
Source: Eurostat, GGDC, own calculations

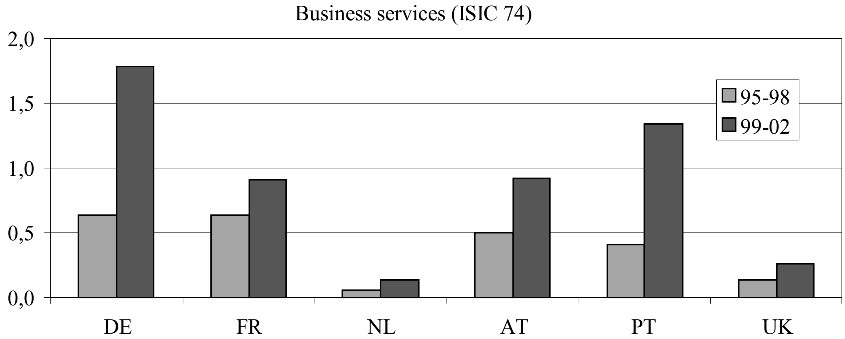
Fig. 45. Absolute Inward FDI Stocks and FDI/VA-Ratios: Research and Development

3.6 Business Services n.e.c. (ISIC 74)

The sector "business services n.e.c" has by far the highest absolute inward FDI stocks (the first panel in Fig. 46). Over the whole period considered, Germany has the largest inward stocks with a strong increase from the end of the nineties to 2000. Since then it remains on a very high level. France and on a much lower path also the UK realised a moderate increase since the end of the nineties. The other countries considered lurch on a low level.

The dramatic increase of the German inward FDI stock and its leading position is also reflected in the relative numbers (the second panel in Fig. 46). While France had nearly the same inward FDI-stock-to-value-added ratio like Germany in the first period, it was passed by Portugal in the second period and is now on the same level as Austria. Furthermore the ratios of the UK and the Netherlands are comparatively low.





Source: Eurostat, GGDC, own calculations

Fig. 46. Absolute Inward FDI Stocks and FDI/VA-Ratios: Business Services n.e.c.

3.7 Effects explaining Inward FDI-to-Value-Added-Ratios

Analogously to the analysis of the determinants of the differences between the outward FDI-to value-added ratios between the countries, sectors and time periods considered, we also undertook a three factor variance analysis with interaction effects for the logs of the inward FDI-to value-added ratios by means of a regression model with dummy variables. Altogether, the model explains 95.00 percent of the variation of the dependent variable (Table 22). Again, the time effect is highly significant and explains roughly seven percent of the variation in the data. All other things equal, the ratios in the second period are on average 83 percent higher than in the first period. The country effects are now responsible for approximately 26 percent of the variation of the log inward FDI-stocks-to-value-added ratios, while they explained only ten percent of the variation of the log outward FDI-stocks-to-value-added ratios. A closer look on the estimation results show that, again other things being equal, there is no country specific difference between Germany and France, while the Netherlands as well as the UK have on average higher ratios and Austria as well as Portugal have on average lower ratios than Germany (cf. Table 38).

Table 22. Variance Analysis for the Inward FDI/VA-Ratios

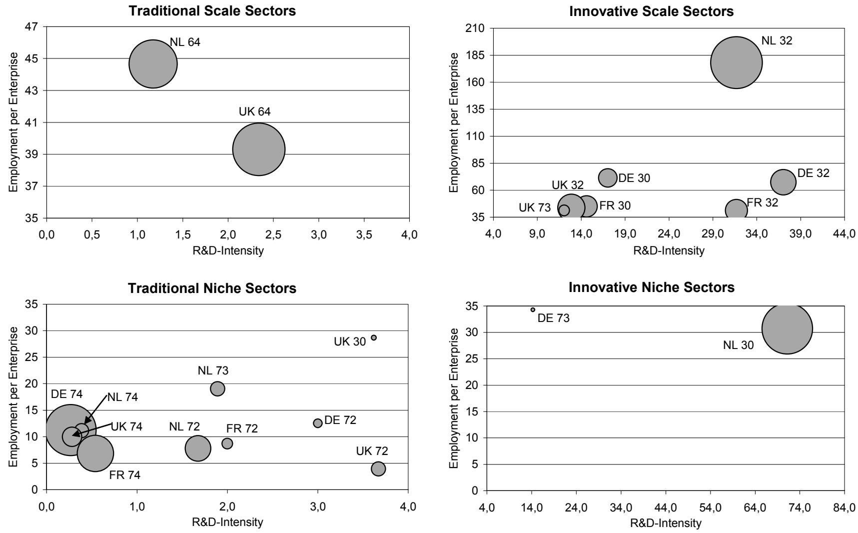
Source	Partial sums of squares		Degrees of	Mean	F-value	Signifi-
	Absolute	In percent	freedom	unbiased sum of squares		cance level
Model	153.88	95.00	36	4.27	17.41	0.000
Time effect	11.75	7.26	1	11.75	47.88	0.000
Country effects	41.94	25.89	5	8.39	34.17	0.000
Sector effects	28.64	17.68	5	5.73	23.33	0.000
Interaction effects	59.96	37.02	25	2.40	9.77	0.000
FR x sector	0.70	0.43	5	0.14	0.57	0.720
NL x sector	17.42	10.75	5	3.48	14.19	0.000
AT x sector	16.98	10.48	5	3.40	13.84	0.000
PT x sector	6.51	4.02	5	1.30	5.31	0.001
UK x sector	10.37	6.40	5	2.07	8.45	0.000
Residual	8.10	5.00	33	0.25		
Total	161.98	100.00	69			

Furthermore, the sector effects are also statistically highly significant and explain approximately 18 percent of the total variation. Taking the sector “office, accounting & computing machinery” as the standard of comparison, the sector “radio and television & communication equipment” has – other things equal – on average the same logs of inward FDI-stocks-to-value-added ratios (significance level: 10.58 percent). The sectors “telecommunications”, “computer & related services” and “research and development” have on average lower averages than our standard of comparison, while the sector “business services n.e.c” has on average higher ratios.

Finally, the interaction effects between countries and sectors explain roughly 37 percent of the total variation in the data. Unlike as for the outward FDI-stocks-to-value-added ratios show a closer inspection now that the significance of the interaction effects is widespread. Only the interaction effects between France and the sectors are statistically not significant.

Altogether, our findings show that a simple model taking into account country, sector, time and interaction effects between countries and sectors can also explain a large amount of the variation of inward FDI-to-value-added ratios within our group of EU countries.

The assignment of the sector-country-combinations is naturally the same for inward FDI stocks as for outward FDI stocks (see Fig. 47). However, the sizes of the bubbles and above all the dispersion of the sizes in the four fields change in different directions. In the field for innovative scale sectors a reduction of the dispersion of the bubble sizes is clearly observable. This means that the degree of foreign engagement by means of FDI is in this field rather similar – with the exception of the engagement in the Netherlands. In the field of innovative niche sectors, the size of the bubbles remains unchanged, what means that the relative distance between Germany and the Netherlands in this field is the same for outward and inward FDI stocks. In the field of traditional niche sectors the relative (and absolute) dominance of Germany is clearly higher for inward FDI stocks than for outward FDI stocks. Finally, the relative position of the Netherlands and the UK in the field of traditional scale sectors is now nearly the same, while it is smaller for the Netherlands in the case of outward FDI stocks.



Source: Eurostat, GGDC, OECD Anberd, own calculations

Fig. 47. Assignment of ICT Related Sectors according to Knowledge intensity as well as Importance of Scale and Inward FDI Stocks to Value Added Ratios

Again the other way around, we are also interested in knowing whether the inward FDI-to-value-added ratios are affected by the importance of scale and knowledge intensity of the receiving sectors. Table 23 shows that this is actually the case. Importance of scale, approximated by employment per enterprise, has a positive impact on the inward FDI-to-value-added ratio at a significance level of five per cent, while it is not significant when value added per enterprise is used as an approximation. The R&D intensity is highly significantly different from zero in all four variants of the model. The country effects are not statistically significant, indicating that foreign investors in the area of ICT do not have preferences for certain host countries, neither for France, Germany, the Netherlands nor for the United Kingdom. However, sector effects are again at least different from zero at significance levels of three per cent in the model II and eight per cent in the model

IV, implying that certain sectors systematically have different FDI-to-value added ratios, which cannot be explained by variations of either importance of scale or knowledge intensity.

If the R&D intensity of the receiving sectors in the host countries is an important determinant of inward FDI stocks, as the regressions results show, the effects on domestic firms – especially with regard to their innovation activities – depend on the various forms of investment (Co, 2000). If new business start-ups are considered ("greenfield" investment), then it can be expected that the domestic firms will increase their R&D expenditures or their innovation activities, not only because of the industry-level capacity expansion, but also because of the firm-specific advantages of the foreign investors. Conversely, no capacity expansion takes place with firm takeovers and the market shares of the remaining domestic firms remain constant first of all, so that there is no direct cause to increase innovation efforts. Here, the possible effects depend on the relationship of the technology of the acquired firm to the technology of the buyer firm. If the former is superior, then it can be expected that the firm will extend its R&D activities under foreign ownership in order to learn more about the bought-in technology, while in the latter case it will increase its R&D efforts in order to adapt its technology to the requirements of the host country.[2]

Table 23. Regression Analysis for the Inward FDI/VA-Ratios

Variable	Model I	Model II	Model III	Model IV
EMPEN	0.010	0.011	---	---
	(1.887)	(1.843)		
VAPEN	---	---	0.176	0.168
			(1.000)	(0.752)
RDINT	0.041	0.043	0.045	0.048
	(3.732)	(3.280)	(3.777)	(3.380)
Likelihood-ratio tests				
Country effects χ^2	3.118	---	4.452	---
	(0.374)		(0.217)	
Sector effects χ^2	11.933	12.214	10.355	9.838
	(0.036)	(0,032)	(0.065)	(0.080)
R^2	0.754	0.714	0.725	0.660
Adj. R^2	0.507	0.560	0.450	0.477

[a)] t-values in parentheses. White heteroskedasticity-consistent standard errors are used to calculate these statistics.
[b)] Significance levels in parentheses.

[2] In addition to the utilization of comparative advantages and overcoming market imperfections, the possibility of obtaining access to the technologies of the host country and to learn from them is in the interim regarded as a third reason for FDI (cf. Peng and Wang (2000) on this). Thus on the basis of their econometric analysis of the sectoral FDI flows in the four big EU countries, Neven and Siotis (1996) conclude that this motive could be significant for FDI originating in the US and Japan, but not for the intra-EU FDI.

From our empirical findings some general conclusion can be drawn. First of all, it is obvious from Table 24 that in 2002 the overwhelming amount of outward as well as inward FDI stocks of the four countries which could be considered is in the field of traditional niche sectors, whereby these positions are rather well-balanced with a small surplus of inward FDI stocks. For the outward FDI stocks in business services n.e.c. it can be assumed rightly that they are of the market-seeking type and replace the exports that are not possible because of the necessary double coincidence, which means that transactions of services in most cases require the spatial and temporal proximity of buyers and sellers simultaneously. Thus, these foreign activities are no threat to growth and employment in the home countries. For the outward FDI stocks of computer and related services, the second important sector in this field, the situation might be a little bit different. Here is actually some further research necessary. On the other hand, the large inward FDI stocks in both sectors increases competition in domestic markets. One possibility for domestic firms to react to this competitive pressure is to increase innovation activities (cf. Blind/Jungmittag, 2004). Thereby, it is usually assumed that product innovations allow fetching higher prices, while process innovations lead to cost reductions. Another reason for domestic firms to increase their innovation activities simply involves the firm-specific advantages of the foreign investors. However, if inward FDI takes place in the form of mergers and acquisitions and there are no capacity effects, there is also no direct cause to increase innovation efforts. Here, the possible effects depend on the relationship of the technology of the acquired firm to the technology of the buyer firm. If the former is superior, then it can be expected that the firm will extend its R&D activities under foreign ownership in order to learn more about the bought-in technology, while in the latter case it will increase its R&D efforts in order to adapt its technology to the requirements of the host country.

Table 24. FDI Stocks of DE, FR, NL and UK (Million Euro) in 2002

Field of Classification	Outward FDI Stocks	Inward FDI Stocks
Innovative Scale Sectors	30807	33116
Innovative Niche Sectors	5470	3076
Traditional Niche Sectors	540431	569059
Traditional Scale Sectors	245329	73441

The second largest amount of outward and inward FDI stocks can be found in the field of traditional scale sectors, where the outward FDI stocks are three times as high as the inward FDI stocks. Since only the sector telecommunications is located in this field, it can be assumed that outward FDI stocks are largely market-seeking and no threat for growth and employment in the home countries. The only exception might be the offshoring of some low skill activities – like call centers – which implies a certain degree of production fragmentation and therefore a certain threat for low skilled employees. For the inward FDI stocks applies the same argument as for the field of traditional niche goods.

In the field of innovative scale sectors the outward and inward FDI stocks are also rather well-balanced with a small surplus of the inward FDI stocks. Here, we surely can assume that outward FDI is a means of production fragmentation. If this fragmentation of the value added chain increases overall competitiveness of the sectors in the home countries, we might expect an overall positive impact on growth and employment in those countries. However, at the same time, it might intensify pressure on relative wages and impair employment opportunities for low skilled employees.

Finally, in the field of innovative niche sector, which shows the smallest amount of outward as well as inward FDI stocks and a clear surplus of outward FDI stocks, the economic effects obviously might depend on the individual sector. While we can assume quite legitimately that outward FDI stocks of the sector “office, accounting & computing machinery” are at least partly a means of production fragmentation with the effects just mentioned for the innovative scale sectors, outward FDI stocks of the sector “research and development” are largely market-seeking.

CHAPTER V. Internationalisation of R&D in ICT

Bernhard Dachs and Georg Zahradnik

1 Introduction

An important aspect of the ongoing integration of the world economy is the internationalisation of research and development. Enterprises not only produce and sell, but also increasingly develop goods and services outside of their home countries. The internationalisation of R&D is not a new phenomenon, but has gained momentum in recent years (Veugelers 2005, Part 1). A considerable part of this acceleration can be attributed to the activities of multinational enterprises (MNEs). MNEs increasingly locate R&D and innovation activities outside of their home country (Narula and Zanfei 2005; Veugelers 2005).

This chapter takes a closer look at the magnitude and at the patterns of these developments using patent data. Since R&D is a knowledge intensive activity, the internationalisation of R&D in ICT is most relevant for the two knowledge intensive sectors of the four-sector typology discussed in chapter II. These sectors are innovative scale and innovative niche product sectors. We will therefore focus on ICT industries in these two areas. R&D internationalisation in these two sectors may be more technology-driven, leading to dispersed R&D activities around the world and R&D units located where high-quality scientific input may be expected.

R&D internationalisation may also occur in the two other less knowledge-intensive sectors. However, since scale and other factors than knowledge may be more relevant for economic success, R&D internationalisation is less relevant than in the knowledge-intensive sectors. Foreign R&D facilities will mainly support production and marketing activities by adopting existing technologies to foreign markets.

Section 2 of the chapter will examine the relevant literature in relation to the internationalisation of research and development. In addition to that, it will discuss the main arguments brought forward to exemplify the process. Furthermore, in section 3 we will examine how research and development activities in the field of ICT have spread over countries in recent years with patent data. The final section of this chapter summarizes the main findings of the analysis and gives some conclusions.

2 R&D Internationalisation Strategies of Enterprises

The theoretical analysis of the question why firms locate R&D and other innovative activities abroad received important contributions from a number of different research streams within the economic literature, including the international business literature dealing with foreign direct investment and the Neo-Schumpeterian economics of innovation and technological change.

The literature (see the reviews of Narula and Zanfei 2005 and Veugelers 2005) discusses two basic strategies of how multinational enterprises organize cross-border innovation activities. A very interesting distinction of these two basic motives to decentralize research and development has been a brought forward by Kuemmerle (1999) who distinguishes between 'Home-Base Exploiting' (HBE) and 'Home-Base Augmenting' (HBA) strategies.

2.1 Home Base Exploiting Strategies

'Home Base Exploiting' (Kuemmerle 1999) or 'Asset Exploiting' (Dunning and Narula 1995) describes a strategy where foreign-owned affiliates are mostly exploiting existing knowledge to support foreign production by doing minor development work in adjusting existing technologies and products. Knowledge relevant for the innovative activity at the affiliate mainly originates from within the multinational group. External linkages to firms, universities or public laboratories in the host country are only of minor importance for the innovative outcome of the affiliate. The most important information sources that contribute to innovative performance of the affiliate reside inside the MNE.

'Home Base Exploiting' – approaches to explain the internationalisation of R&D are rooted in the framework of the theory of the multinational enterprise and the international business literature (Dunning 1973; Markusen 1995; Barba Navaretti and Venables 2004). Multinational enterprises exist because they possess firm-specific assets like technological knowledge, well-known products and brands, design or management capabilities, etc. These assets are intangible, fully appropriable and transferable within the firm. MNEs use these assets to enter foreign markets because they give them advantages over incumbent competitors. To fully exploit these assets, they have to be adopted to local needs, consumer tastes, regulation etc. Engineering and design activities are located in the MNEs target markets of to do these adjustments close to the customers and production facilities abroad.

The explanation brought forward by the international business literature can explain a lot of the characteristics of the current internationalisation of corporate R&D. If foreign R&D mainly supports local production of MNEs, it seems clear that innovative activities are less internationalized than production or sales activities. The incentive for MNEs to support local production with R&D and design units increases with the size a foreign market and the production volume of the MNE in this market. Companies have no need for R&D abroad below a certain market size.

HBE argues that internationalisation of R&D has to be seen in the broader context of international trade, foreign direct investment and other aspects of internationalisation. R&D and innovative activity acts as an auxiliary function of overseas production and sales activities.

This auxiliary function of overseas innovative activities does explain why the internationalisation of innovative activities is largely an intra-Triad phenomenon (Veugelers 2005, p. 5). North America, Europe and Japan are still the largest and most important markets for the products of MNEs despite high growth rates in China and India. However, as aggregate income rises in Asian countries, we will envisage a much more innovative activity of MNEs in these countries as well.

The theoretical approach presented above can also explain some organisational features in respect to overseas R&D of MNEs. Since strategic, long-term research is concentrated at the home country of the company, the intensity of R&D activities abroad will be below the intensity at home. This is seems to be the case for most US multinational corporations (see Markusen 2002, p. 16). Moreover, the concept of 'asset exploiting' also assists us in comprehending why patterns of technological specialisation of MNE affiliates abroad are similar to the patterns the companies exhibit at home, as shown by Patel and Vega (1999) and le Bas and Sierra (2002). If these overseas activities are just adjustments to developments made at home, it seems clear that the enterprise is also specialized in the same technologies.

2.2 Home Base Augmenting Strategies

'Home Base Augmenting' (Kuemmerle 1999) or 'Asset Augmenting' (Dunning and Narula, 1995) is the second basic strategy of R&D internationalisation. Here, foreign-owned affiliates are actively contributing to the stock of knowledge and the range of products of the group as a centre of excellence. Knowledge relevant for the innovative activity of the affiliate originates from within the group, but also from its environment in the host country. Therefore, external linkages to firms, universities or public laboratories in the host country are of a much larger importance and foreign and domestic enterprises are in a more dynamic and vivid exchange than in the HBE strategy. We may also assume that direct linkages to various external information sources like universities or public research centres are more important than in HBE.

The idea that firms exchange knowledge with their environment is closely connected to the concept of a 'System of Innovation' (see Edquist 2005 for an overview of the literature) brought forward by the Neo-Schumpeterian literature on innovation and technological change. The basic idea of this approach is that the firms normally do not innovate in isolation, but are embedded in an environment. The innovative outcome of a company cannot be explained by internal factors alone. Instead, innovative performance is also shaped by the underlying system of innovation at the national, regional or at the sector level (Malerba 2002).

A system of innovation consists of *institutions* – some examples of these institutions are as follows: laws, rules, norms, established practices and routines – other *organisations* and *relations* between the firm and this environment. Important institutions for the development of ICT in a country are, for example, intellectual property rights, standards, but also more general factors such as the general attitude of the population towards science and technology, or the organisation of higher education in a country.

Another important feature of the systems of innovation approach is the importance laid on interdependence, external relations, and interactive learning of the innovating firm. Firms accumulate knowledge from these external relations, via various market or non-market channels –like formal co-operations or informal spillovers. Most important external providers of knowledge for the innovative activities of firms are universities and research centres. Various authors (for example in Lundvall 1992) have also pointed out the importance of user-producer relations for innovative activity, an idea that has been taken up with regard to the internationalisation of R&D by Mayer-Kramer and Reger (1997) or Beise (2004) in the concept of "lead markets".

Knowledge flows are bounded in space and diminish with distance between sender and receiver (Jaffe *et al.* 1993; Breschi and Lissoni 2001). As a consequence, firms that want to utilize such localized knowledge spillovers have to be present where they occur. Moreover, useful knowledge for innovation is not equally distributed across the world. The literature on clusters and industrial agglomerations has brought rich evidence for this phenomenon. Some prominent examples are Silicon Valley or the Cambridge area (Bresnahan and Gambardella 2004).

If we assume that knowledge and spillovers are locally bounded and some locations offer more favourable framework conditions for innovation than others. MNEs have to pursue activity at these locations – in order to capture the aforementioned advantages. As a consequence, foreign-owned affiliates run centres of competence for certain technologies and product groups in a country that has a particular advantage point in this technology, or act as ‚surveillance outposts‘ and ‚antennas‘ to monitor the technological activities of competitors and clients (Florida 1997; Almeida 1999).

Decentralisation is not costless and includes some trade-offs which have to be set-off by advantages derived from a more decentralized R&D structure (Zanfei 2000, Sanna-Randaccio and Veugelers 2003). A first disadvantage of decentralisation is that information and knowledge flows between headquarter and affiliates are now two-way which incurs further cost and losses; secondly, central research departments may lose economies of scale in R&D; and thirdly, secrecy decreases and the probability of involuntary spillovers increase with a rising level of decentralisation.

Beside these general considerations, an analysis of the motives and boundary conditions of the internationalisation of innovative activities in ICT must also consider the heterogeneity of industries within the ICT sector. The delivery of telecom services, for example, is locally bound (Bhagwati *et al.* 2004), and the service seller may have to move to the location of the service buyer. This may also shape the organisation of R&D.

The decision to follow a HBA strategy also depends on the learning and knowledge environment in which firms operate. Orietta Marsili (2001) uses the term 'technological regime' to refer to these sector characteristics. A technological regime defines the nature of the problem firms have to solve in their innovative activities; affects the form of technological learning; shapes the incentives and constraints to a particular behaviour; and lastly, influences the basic processes of variety generation and selection.

Knowledge-intensive industries- which include innovative scale sectors and innovative niche products sectors, for example, may have a higher incentive for HBA strategies - since knowledge is central to their activities and the accumulation of new knowledge may be a major incentive to go abroad. Sectors where international expansion is a means to exploit scale advantages may be more oriented towards HBA strategies, because they enable them to sell their products at international markets.

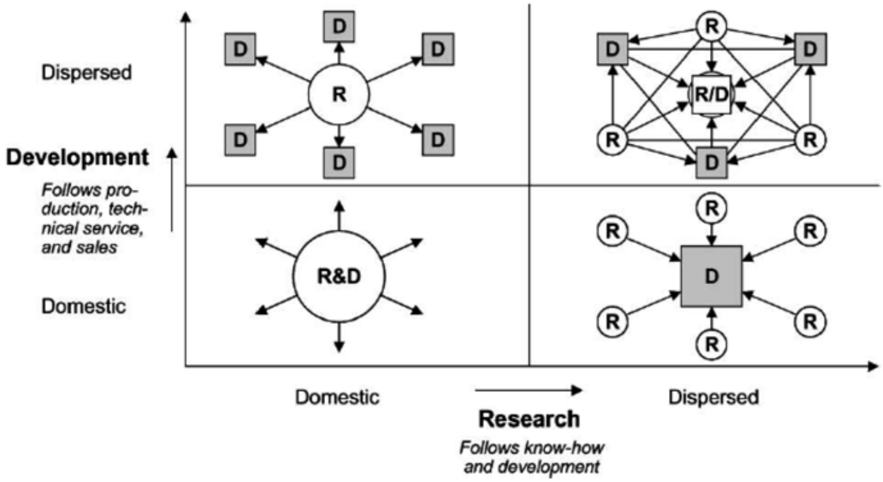
The concept of 'technological regimes' has not yet been applied to service industries. It is obvious that telecommunications or software industry faces completely different learning and knowledge environment than the one described above. Innovation in service industries in general is much more driven by suppliers of equipment, by customisation and interactions between client and supplier than in manufacturing industries (Miles 2005). As a consequence service industries follow different approaches to the internationalisation of innovative activity.

2.3 Extensions of the Basic Dichotomy

Von Zedtwitz and Gassmann (2002) expand the dichotomy of HBE and HBA and distinguish four different strategies of R&D internationalisation according to the location of research and development activities. They are:

- "National treasure R&D". With this strategy, both research and development is located at home. Von Zedtwitz and Gassmann argue that the main reason for this strategy is to keep core technologies under control.
- "Technology-driven R&D". Research is more internationalized than development activities. Companies do R&D abroad to access local knowledge and react to scarcities of scientific personnel at home. Von Zedtwitz and Gassmann (2002, p. 577) present Xerox as an example of this strategy. However, they admit that this organisational type is rare.
- "Market-driven R&D". R&D abroad mainly monitors technologies and is driven by customer demands and not scientific exploration. The authors describe this type as "the most prevailing and obvious way" of R&D internationalisation, which is pursed in almost all industries (von Zedtwitz and Gassmann 2002, p. 583). This strategy is particularly found in industries which are rather driven by demand and clients' requirements than by scientific advancements. Companies concentrate their research at home to retain a critical mass and decentralize their development efforts to provide capacities for clients in the main markets. This organisation form is also a reaction to the requests of global customers for local development support. It is often found in industries where products are customized, like the investment goods industry.
- "Global R&D". Both scientific research and development are dispersed across countries. Von Zedtwitz and Gassmann (2002, p. 579) find this archetype, for

example, in the pharmaceutical industry. It is the organisational form that may require the highest co-ordination efforts and where the trade-offs described above may be largest.



Source: Von Zedtwitz and Gassmann (2002, p. 575)

Fig. 48. Four Different Archetypes of R&D Internationalisation

What is the prevailing type of strategy in ICT industries? Apparently, von Zedtwitz and Gassmann find no strict preference of certain industries to one of the four types, but they do observe some regularity:

They find that "market-driven R&D" is the prevailing strategy and that this is applicable for the majority of ICT industries – where local clients have to be served with development capacity. In the four-sector classification used in this study, we may speak of traditional niche products and traditional scale sectors. Examples of industries where development is located in target markets are the software and IT consulting or producers of electronic components[1]. The authors observe that information technology and electrical industries have "a moderate emphasis towards more domestic research" (von Zedtwitz and Gassmann 2002, p. 583). However, they also find other examples in ICT, namely some IT companies with preference in "Global R&D". In these cases, the advantages of global organisation not only for research, but for development as well seem to outweigh the disadvantages discussed above – like the danger of loss of control and protection. We may suspect that this is the case only in the most knowledge-intensive industries of ICT, innovative scale sectors and innovative niche product sectors. Some examples are semiconductors and telecommunications equipment. A close contact to first-class scientific knowledge at certain universities or clusters, or tapping into

[1] A good example is the case study on AT&S in Chapter VI.

informal networks which can only be accessed in certain locations - is essential in these industries.

A different taxonomy of R&D internationalisation has been proposed by Daniele Archibugi and Simona Immarino (1999), who distinguish three broad categories:

- International exploitation of technology produced on a national basis
- Global generation of innovations
- Global technology collaborations

International exploitation includes all attempts to obtain economic advantages through the exploitation of own technological competence in markets other than the national one. This strategy contains exports as well as FDI and licensing of patents. For ICT industries, we can assume that international exploitation mainly takes place within multinational enterprises. Barba Navaretti and Venables (2004, p. 11) report that the manufacturers of electrical and electronic represent the second-largest share in the worldwide stock of FDI within manufacturing, only excelled by the chemical industry. Moreover, a number of ICT-related activities in the service sector such as telecommunication or software development are also dominated by large multinational firms.

ICT has also a high share on world trade (see Chapter III of this book). The exports as percentage of total production in ICT sectors are considerably above other sectors and also above the average in manufacturing (OECD 2004b, p. 228 – 230). Universities and governments are not active in the international exploitation of ICT, an exception may be the licensing of university patents.

The second category, *global generation of innovations*, contains innovations conceived on a global scale from the moment they are generated. Like in the International Exploitation strategy, multinational enterprises are also important actors in this type of globalisation. R&D investments of foreign-owned affiliates comprise more than 50% of all R&D expenditure in the business sector in Hungary, Ireland and the Czech Republic; around 40% in Spain, the UK, and Sweden; and more than 20% in Germany, France and the Netherlands (OECD 2004a, p. 41). Foreign affiliates account for 11% of all R&D expenditure in the US computer and electronic products industry and for 18% in the US electrical equipment industry (National Science Foundation, 2004, p. 4-57).

However, to complement Archibugi's and Iammarino's classification, not only companies, but also researchers are mobile. According to DG research, 87,000 researchers originating from EU15 worked in the US in 2000. In turn, 41,000 researchers from the Americas (including Latin America and North America) have been employed in the EU15 countries in 2000. In total, around 4% of all S&T employees in the EU member states are from other countries than the ones where they are currently employed, and 2% are from outside the EU (European Commission 2003, p. 224).

Global techno-scientific collaborations is a third internationalisation strategy. The number of such arrangements has increased considerably in the last 20 years (Hagedoorn, 2002) Alliances allow firms to share costs and risks of R&D projects and exchange knowledge on a mutual basis. They are usually closed between enterprises, but also between enterprises and universities. Nokia, for example, has closed a number of cooperation agreements with universities in Europe, Asia and North America[2]. Moreover, the formation of joint R&D projects in ICT is also promoted by national governments and at the European level - by the European Commission with its Framework Programmes for Research and Technological Development (FWP). Within FWP 6 (2002-2006), the EC will support collaborative research in the field of information society technologies with nearly 4 billion Euros[3].

3 Empirical Analysis

We will now employ patent data to measure the internationalisation of R&D in the field of information and communication technologies and see how research and development activities are spread over countries.

Our analysis poses and aspires to answer the following questions:

- What are the general trends in ICT research as measured by patents in Europe?
- Has the geographical concentration of ICT research changed over time?
- What trends can be observed at the level of individual companies?

3.1 Data and Methods

3.1.1 Patents as a Measure of Innovative Activity

A patent is an intellectual property right issued to protect technological inventions. By granting these rights to inventors, the patent system enhances the approbability of inventions and therefore stimulates the creation of novelty (Griliches 1990). Figure 49 shows a patent file granted by the European Patent Office. A patent file first describes the invention that is protected by the patent by its title, an abstract and the technology classification. Moreover, a patent file reports the first application of this invention at any patent office (priority date), the owner or applicant of the patent and its inventors.

The patent system is also a rich source for detailed information on the state of the art of technological change. Patents are frequently used for analyzing technological change and open a “window on the knowledge economy” (Jaffe and Trajtenberg, 2002, p. 2) to researchers.

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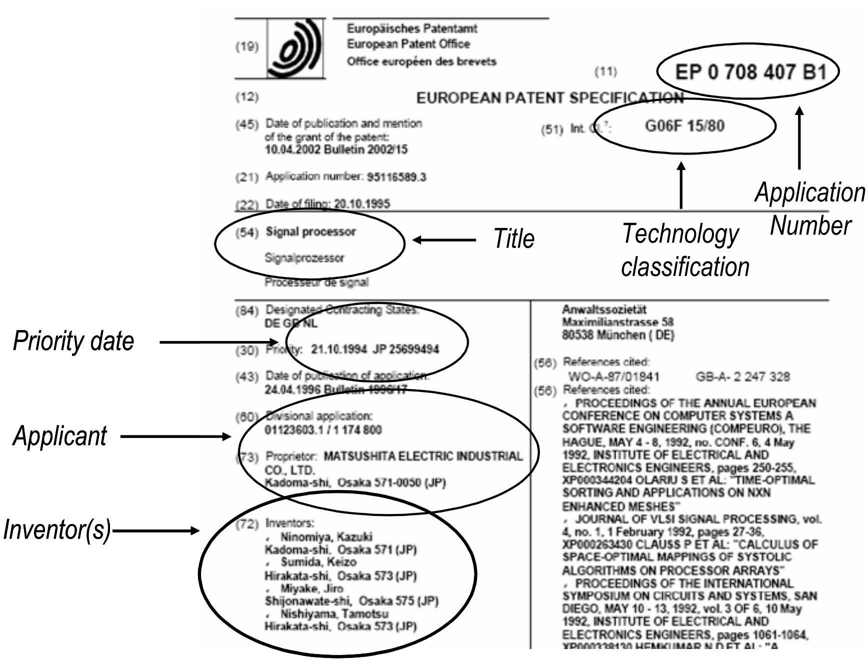
[2] http://www.nokia.com/nokia/0,,5130,00.html

[3] http://www.cordis.lu/fp6/budget.htm



Source: European Patent Office

Fig. 49. Patent File at the European Patent Office

The following features make patents very useful for the analysis of technological change (Griliches 1990; Hinze and Schmoch, 2004):

- First of all, patents directly represent technologies, not companies or proxies for technologies. Patents are the outcome of an innovation process and are expected to be economically valuable one way or another; either by using them, or by preventing their use by competitors. Otherwise, the company would not apply for a patent. Therefore, patents also reflect the competitive dimension of technological change.
- Second, the databases of the major patent offices provide very long time series for patenting activities. Computable data from the US Patent and Trademark Office, for example, goes back until 1920 (Grupp 1997, p. 159). Moreover, patents may provide information on technological activities in countries where no other data (like R&D expenditure) exists.
- Third, International Patent Classification (IPC) is more detailed than the classification schemes for publications (Science Citation Index) or the classification of economic activities (NACE). This permits a better analysis of technology in much more detail than it would be possible with other data. An impressing example is Manuel Traijtenberg's (1990) study on the development of CT-scanners.
- Another important merit of patent data is that it is not anonymous. Patent files name the owner and the inventor of a patent, including their place of residence.

This allows to study, for example, the technological specialisation and strategies of single firms (Patel and Pavitt, 1997), the geographical dispersion of innovative activities over time (Le Bas and Sierra, 2002), or the personal characteristics of inventors (Giuri *et al.* 2005).

Despite its advantages, patent data has also some shortcomings (Griliches 1990; Patel and Pivot, 1995; Smith, 2005):

- First, patents are rather an indicator of invention than of innovation - since a patent file protects a technical principle and not its commercial application. Patents, therefore, differ greatly in their economic value (Traijtenberg 2002).
- Second, innovative activity does not necessarily lead to a patent. There are alternative mechanisms of protection, like secrecy, lead-time over competitors, or the use of complementary marketing and manufacturing capabilities which may be considered more efficient and can supplement or even replace patent protection (Cohen *et al.* 2000). Moreover, companies are using R&D inputs more or less efficiently. These two factors cause the propensity to patent to vary between industries.
- Third, some inventions or types of technology are not patentable at all and for some technologies (like software) it is still debated - if patent protection can be granted. Therefore, patents are no appropriate indicators to study innovation in large parts of the services sector, but also in some manufacturing industries.
- Fourth, the examination of a patent application by the patent office is time consuming and increases time lags between the invention and final grant of the patent. In the 1980s and 1990s, the gap between filing and grant was on average about two years. Patent documents usually have three different reference dates and are as follows: priority date (refers to the first date of filing a patent application - anywhere in the world – in order to protect an invention). The other two reference dates are application date and date of grant. Patent indicators are usually computed on the basis of the priority data since this date is closest to the original invention. Due to the time-consuming process of patent examination, a patent with a grant in 2005 can have a priority date of 2001 or even earlier.

Since a patent protects both the owner's and the inventor's rights, patents are also very useful for studies of the internationalisation of technology. By comparing these two locations, one can derive a measure for the ownership of cross-border patents[4], which can be used as an indicator of the internationalisation of R&D activities (Guellec and van Pottelsberghe de la Potterie, 2004). We speak of a cross-border patent when the applicant and at least one inventor reside in different countries. This may be the case, for example, when a German enterprise applies for a patent for an invention made by a researcher located in the Czech Republic. The Czech inventor may be doing contract research for the German enterprise, or work for a Czech affiliate of the enterprise.

[4] The application of inventions made abroad as cross-border patents should not be confused with the application of a patent at different patent offices

This approach has yielded in a considerable amount of literature analyzing the internationalisation of R&D with patent data over the last years (Dernis and Guellec, 2001; Guellec and van Pottelsberghe de la Potterie, 2001; le Bas and Sierra, 2002; OECD, 2005). The results of these studies indicate that both, the share of foreign applications of domestic inventions, as well as the share of foreign inventions on domestic patent applications has increased in most countries during the last decade. Important factors which determine the degree of patent internationalisation of a country are its size, its research intensity, and geographical factors - like common borders or common languages between two countries (Guellec and van Pottelsberghe de la Potterie, 2001). Small countries tend to be more internationalized, while R&D intensity is negatively related to internationalisation.

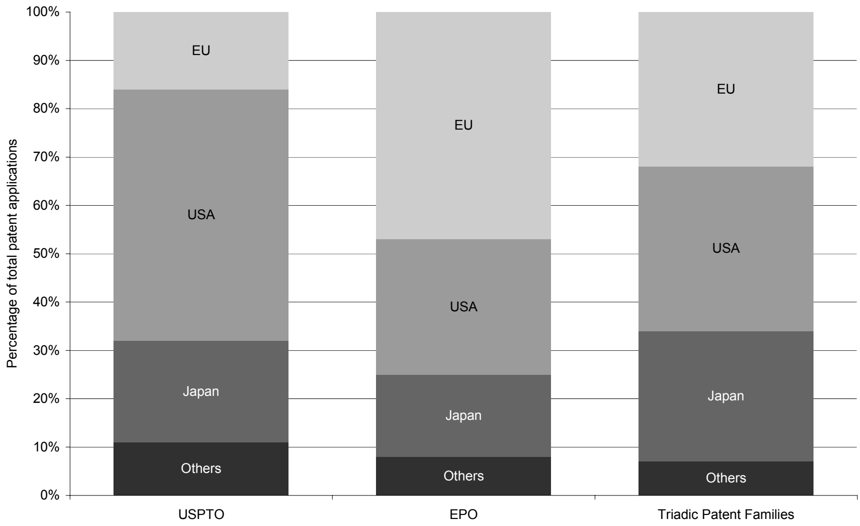
The analysis of internationalisation of R&D with patent data, however, has focussed on the general level of patenting activity so far. To our knowledge, there are no studies dealing of internationalisation in a particular technological field. We will present such an analysis in the preceding sections of this chapter.

3.1.2 Data

The most important decision regarding cross-country comparisons of patent data is the choice of the patent office (Hinze and Schmoch, 2004). Enterprises, universities as well as private inventors tend to apply for a patent in their home country first. Patent protection may be later expanded to other countries if the invention becomes a success; but the first application will always be made in the home country. Therefore, the decision to use data of a single patent office will inevitably have an impact on the results received from the analysis. In 1998, for example, the share of European organisations on all patent applications in semiconductors was 35% at the European Patent Office, but only 6% at the US Patent and Trademark Office. On the contrary, the US share on all semiconductor patents accounted for 28% at the EPO, but 42% at USPTO. We would get different results in a comparison of the strengths and weaknesses of Europe and the US in semiconductors if we only use USTPO or EPO data.

To overcome this bias and allow balanced cross-country comparisons, the OECD has developed the concept of Triadic patent families (Dernis and Khan, 2004). Triadic patent families are inventions for which a patent application has been filed at all three patent offices of the Triade, the US Patent and Trademark Office, the European Patent Office and the Japanese Patent Office (Dernis and Khan, 2004).

Figure 50 demonstrates this home country bias and illustrates the advantages of Triadic patent families over patent data from a single office. It shows the shares of various countries on the total number of applications at the USPTO, the EPO and the country share on Triadic patents. In 1999, US organisations held a share of 53% on all patent grants at the US Patent and Trademark Office, but only 28% of all patents at the EPO. At the same time, we see a much higher propensity of European organisations applying at the EPO than at the USPTO. Therefore, an analysis of USPTO data would overestimate the relative share of US organisations in a global perspective – since the USPTO is the national patent office of these organisations and their first choice to protect their inventions. The same applies for European organisations at the EPO.



Source: Dernis and Khan (2004, p. 15)

Fig. 50. Country Shares of Patents Applied for at the EPO, Patent Grants by the USPTO and Triadic Patent Families, for Priority Year 1999

Triadic patent families help to overcome this bias. Here, the share of patents applied to US and EU organisations is rather equal (Figure 50). Moreover, Japanese inventions, which are underestimated at both the US and the EU patent office, now appear with a share of 27% of all worldwide patents.

We use the classification of patents in information and communication technologies proposed by the OECD (OECD, 2006, p. 18). In contrast to the OECD, we approach semiconductors as a distinct technology and distinguish five major fields of ICT technologies: semiconductors, consumer electronics, computers, telecommunication and other ICT. The association of IPC patent codes to the five technologies is given in Annex D.

3.1.3 Measures of Internationalisation

How can internationalisation be measured? Previous studies have constructed an index of cross-border patenting activities, which is the total number of patents of a firm or country invented abroad divided by the total number of patents applied for by the firm or country. Similar indices will also be employed in this chapter.

Moreover, internationalisation can also be regarded as a decrease in the geographic concentration of a particular activity at one location; enterprises usually start with R&D activities in their home countries, and later set-up R&D units in other countries.

We will measure concentration with an entropy index proposed by Karl Aiginger and Stephen Davies (2004). This index has some advantages over other measures of concentration or specialisation - such as the Herfindhal-Hirschman Index or Gini coefficients: first, we can add up changes in individual countries to an overall change. Second, the entropy index employed here includes all entities into calculation and doesn't take into consideration only the very largest (Aiginger and Davies 2004, p 234f).

The index of concentration for a given technology is defined as:

$$CONC_i = -\sum (\frac{X_{ij}}{X_i}) \ln(\frac{X_{ij}}{X_i})$$

which is the sum of the shares and the log shares of patent inventions in all countries j in a certain technology i.

In its original formulation, CONC has a minimal value of 0, which indicates a complete concentration of a certain technology in one country and a maximal value of the natural logarithm of number of countries. Since a higher degree of concentration is usually not associated with lower values, we apply a simple linear transformation to make the index intuitively accessible. After transformation, the values range between 0 and 100 where 0 stands for an equal distribution and 100 for highest concentration:

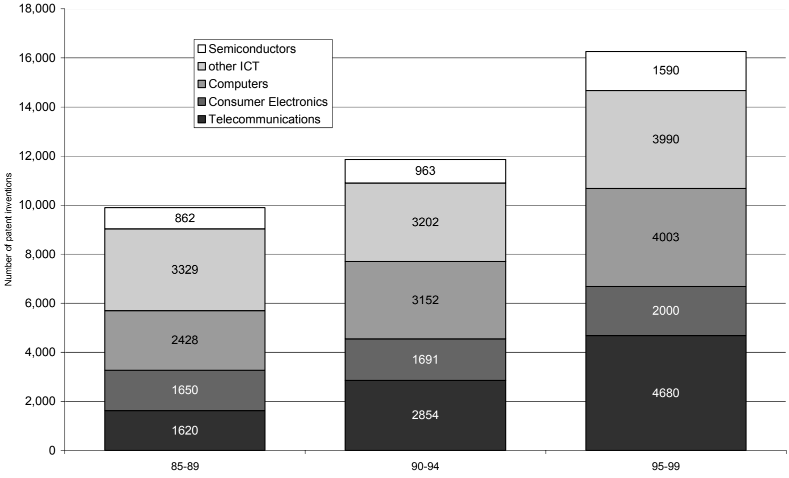
$$CONC_T = 1 - (CONC / \ln(j))$$

The connection between CONC and the internationalisation of R&D is straightforward: if R&D in a certain company becomes more internationalized, we can observe that CONC will decrease since R&D activities are spread over more countries. If the company centralizes R&D, CONC should increase. If R&D activities grow at the same rate at all locations of a specific company, CONC will remain stable.

3.2 Trends at the Country and Technology Level

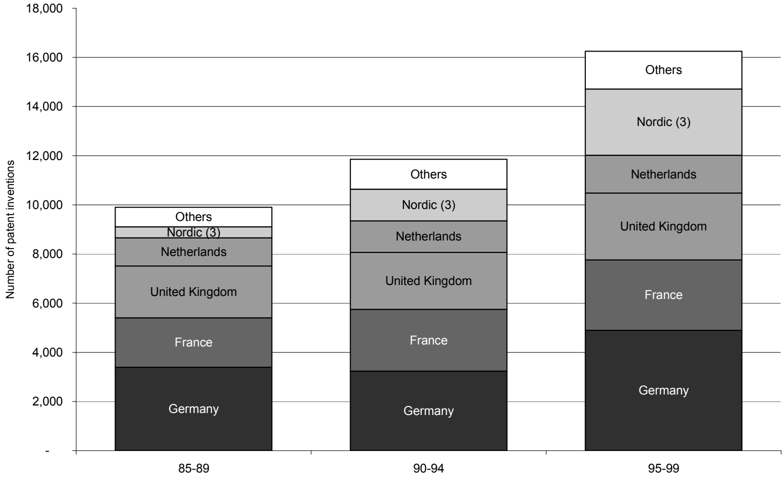
Patenting in information and communication technologies has increased considerably during the 1990s in the EU 25 (Figure 51). A similar trend can also be observed for world-wide patent inventions in ICTs. Telecommunications and semiconductors are the two fastest growing sub-fields within ICTs. Telecom is also the largest sub-field.

In absolute numbers, the largest countries in ICT patenting in Europe are Germany, France, the UK, Sweden and the Netherlands. Together, these four countries account for over 85% of all ICT inventions in all three periods (Figure 52). Finland, Sweden, Belgium and Austria gained shares in the 1990s - while Italy, France, Germany and the UK lost in relative terms. ICT patent inventions grew between the two periods 1990-94 and 1995- 99 in all member countries - except Italy. ICT patenting rose strongest in Austria, Sweden, and the Southern Member states – which include: Cyprus, Greece, Malta, Spain, and Portugal.



Source: OECD Triadic Patents database, own calculations

Fig. 51. Total Number of Patent Inventions in Various Fields of ICT in the EU 25, Priority Years 1985-1999



Source: OECD Triadic Patents database, own calculations

Fig. 52. Total Number ICT Patent Inventions in the EU 25 Member States, Priority Years 1985-1999

The EU member countries in Middle and Eastern Europe (Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovenia, Slovak Republic) have become important locations for the production of ICTs in recent years. Some observers fear that Western European companies may also relocate research and development activities to these countries.

Patent data do not reflect these circumstances. The Middle and Eastern European member states of the EU have only a very small fraction of ICT patent inventions so far. Their share on overall ICT inventions is only 0.2% and remained stable over the 1990s, which means that there was no catching-up but a growth proportionate to that of the EU 25 as a whole. The Southern member states could indeed increase their share on overall ICT patenting, but it is still below 1%.

We now turn our attention to the question of how concentrated ICT patenting is in Europe, or, how equally ICT inventions are distributed in Europe. If concentration in ICT patenting is decreasing over time, this may be an indication that technological activities are relocated and now located in a larger number of countries. It may, however, also be an indication that R&D activities of both, foreign-owned and domestically owned enterprises grow faster in some countries than in others.

Figure 51 already gave an indication of concentration: We see that a relatively small number of countries account for the vast majority of ICT patent inventions. Germany, France, the UK and Sweden together have invented 75% of all ICT patents in the EU 25 during 1985-1999.

Table 25 outlines the concentration measure CONC for various periods and IC technologies. A lower value of CONC indicates a lower degree of concentration. As a general trend, concentration has decreased in most technologies. This trend is most notably found in telecommunications and in computer and office machinery. We see that the cohesion in Europe with respect to innovative activity in these technologies has increased. The observed development is in line with the results of Aiginger and Davies (2004), who find an equal pattern – a weaker geographic concentration - for all manufacturing industries in the EU.

Table 25. Concentration (CONC) in ICT for Various Time Periods, EU 25

	Semiconductors	Consumer electronics	Computers	Telecom	Other ICT
84-87	0.40	0.39	0.35	0.36	0.36
88-91	0.35	0.34	0.32	0.31	0.35
92-95	0.34	0.32	0.30	0.26	0.32
96-99	0.37	0.30	0.28	0.26	0.34

Source: OECD Triadic Patents database, own calculations. Maximum value is 1, minimum value is 0.

If we compare the technologies, concentration is highest in semiconductors and lowest in telecommunications. There has been a remarkable de-concentration in this technology over the observation period which can be mainly attributed to development of the telecommunications industry in the Nordic countries. The new member states in Middle, Eastern and Southern Europe, in contrast, have not yet shown up as important inventor countries for ICT.

To see how de-concentration in various technologies is connected to internationalisation strategies of enterprises, a discussion analyzing patenting at the company level will be provided below.

3.3 Internationalisation in ICT Patenting at the Company Level

One major advantage of patent data is that it is not anonymous and therefore allows us to analyze innovative behaviour at the level of individual firms and groups of enterprises. This is an important feature, given the fact that the emergence of most technologies in recent decades has been a result of the strategies and actions taken by enterprises than by governments. Private R&D spending outnumbers public R&D expenditure approximately five times in ICT. (GFII, 2004).

Here, we will provide a comparative analysis and will examine the internationalisation of innovative activities in four European ICT companies (Philips, Nokia, Siemens and STMicroelectronics) and two US (IBM and Hewlett Packard) and Japanese companies (Sony and Toshiba). The four European companies account for about 12% of all ICT patents invented in the EU 25 in 1999. The internationalisation of patenting at Philips is shown in Figure 53; similar figures for the other companies are found in Annex D.

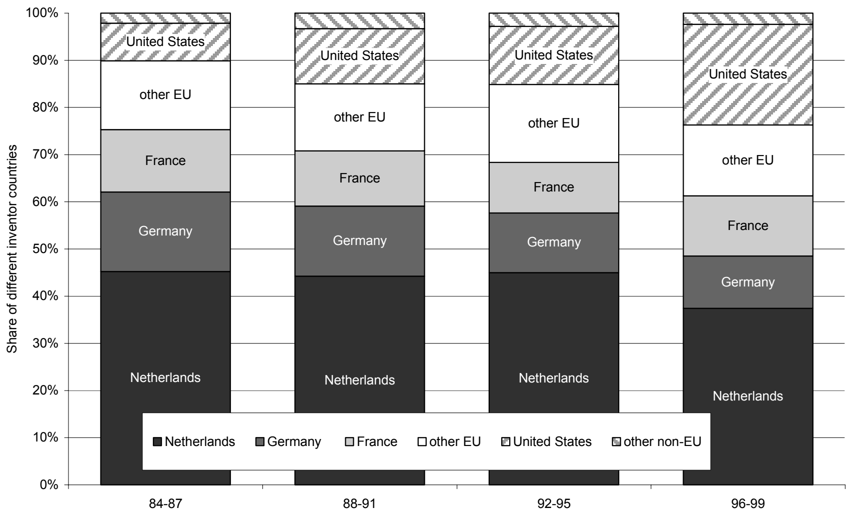
Philips

ICT research and development at Philips was traditionally diversified between research and development centres located in various countries (Reger, 2003). The home country share was below 50% - even in the first period 1984- 87. Other important R&D locations for Philips were Germany, the UK, and France.

According to Reger (2003), Philips went to Germany due to the scarceness of personnel in the home country. Despite the long period, the proportion between these locations remained relatively stable throughout the years, with the exception that the US has become much more important. As a result of this, we cannot speak of a strong de-centralisation or internationalisation of R&D at Philips – since R&D was always organized globally. However, there was a shift in the relative importance of countries within the enterprise group.

Siemens

Unlike Philips, ICT research at Siemens (Annex D, Fig.71) was highly concentrated in the home country in the 1980s. As a result of this, the development at Siemens is characterized by the relative losses of the home country to a much higher degree. However, Siemens, however, expanded R&D activities only to a minor degree at other locations in Europe. The share of all other EU locations – except for Germany – on Siemens' patenting activities in ICT never increased significantly over 10%. The main expansion took place in the US, where Siemens considerably increased its R&D activities as measured by patents. The majority (over 60%) of Siemens' research efforts in ICT are still concentrated in Germany, which is much higher than Germany's share on overall turnover of Siemens, which was 23% in 2004 according to the companies' annual report.



Source: OECD Triadic Patents database, own calculations

Fig. 53. Location of ICT Patent Inventions of Philips, Priority Years 1984/87, 1988/92, 1993/95, 1996/99

Nokia

Like Siemens to some extent, Nokia (Figure 72) provides another example of how non –globalization of R&D is still a salient aspect within some European companies. The company always concentrated the vast majority of its R&D efforts in Finland. Besides Finland, the other two noticeable R&D locations in Europe are Germany and the UK. Germany's high share in the first period is the result of the takeover of ITT's German operations by Nokia in 1988. We see that the relative share of these operations on overall patent activity has been reduced in the following period 1992-95, mainly because operations in Finland grew at a much stronger pace than in any other location. Like in the case of Philips and Siemens, R&D activities in the US became more important for Nokia in the last period. However, their share is still below of the three other companies).

STMicroelectronics

Formed by a merger between SGS Microelettronica of Italy and Thomson Semiconducteurs of France in 1997, STMicroelectronics is a blueprint for a company with R&D activities spread over different countries (Figure 73). The principal division of activities between France and Italy is still clearly visible in Fig. 73. Like in the other European companies, however, the US is gaining prominence as a location for R&D. Between 1996 and 1999, about 20% of all patents of the company were invented in the US. Other countries account for a mere 5% of the company's overall activity.

IBM and Hewlett Packard

The location of R&D activities at IBM and Hewlett Packard (Figure 74 and 75) is the mirror image of their European counterparts – since the bulk of activities are located in the home country and only minor shares fall to locations outside the US. These activities are located in the large EU 25 countries and Japan.

The UK is the most important EU 25 location for both companies. In the case of IBM, we see a respectable amount of R&D activity has taken place in Japan (around 7% in the last two periods). Japan is usually not a host country for R&D activities. IBM's activities, however, may be the result of the long-lasting business relationships of IBM in the country.

Sony and Toshiba

The two Japanese companies (Fig. 76 and Fig. 77) are both distinct examples for the non-globalisation of corporate technology and confirm previous results that Japanese companies are reluctant to locate R&D outside of their home countries (le Bas and Sierra, 2002). This behaviour is most pronounced in the case of Toshiba, where virtually all R&D is concentrated in the home country.

Both firms exhibit home country shares of 90% and more. Preferred overseas R&D locations are large European countries and the US. It is interesting to see how both companies do not take advantage of China as an R&D location despite geographical proximity.

Similar Internationalisation Patterns

Although all enterprises vary in details, they exhibit some similar patterns: In the period 1984- 87, all companies had a share of ICT patent inventions originating from EU25 locations of at least 90%. Within the EU 25, the vast majority of these inventions took place in the home country; Siemens, for example, had a home-country share of 95% in 1984 - 87. A similar situation with respect to their home markets can be observed in the case of the four ex-EU 25 companies.

In the 1980s and 1990s, all enterprises expanded activities at locations outside of their home countries. In the case of European companies, the most important host country outside the EU was – and still is – the US by far. The US share on all ICT patent inventions at Philips rose from 8% (1984-87) to 20% (1996-99). A similar development could be observed at Siemens (US share 1996-99: 20%), Nokia (US share 1996-99: 10%) and STMicroelectronics (US share 1996-99: 19%).

The internationalistion of R&D proceeded in a similar way at the four US and Japanese corporations with Europe and the US as major host countries. All cases demonstrate that locations outside the Triad are not important for the internationalisation of their R&D activities. The share of locations outside the EU 25 (except for the US) is below 3% for the period 1995-99 in all four European cases. We find a similar pattern for the US and Japanese companies. This confirms the finding that the internationalisation of R&D is mainly an intra-Triad phenomenon (Veugelers, 2005). We will further investigate the role of locations outside the EU

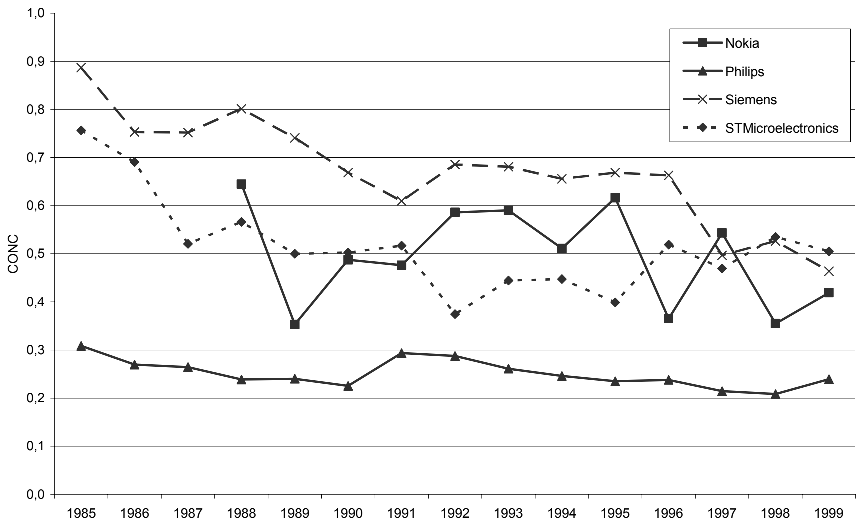
25 with the latest data from the European Patent Office in the final section of this chapter.

Despite these general trends, there is a considerable amount of heterogeneity in the paths and degree of internationalisation, as can be observed in different patterns of the concentration indicator CONC over time (Fig. 54). Philips is the most internationalized company throughout all periods, but does not show a considerable movement over the years. However, as we have seen from the previous figures, there was a shift in the relative importance of various locations in favour of the US. Nokia, Siemens and STMicroelectronics, in contrast, considerably deconcentrated their R&D in ICT over the years.

We can also observe years or periods of re-concentration, like in the case of STMicroelectronics - since the Mid-1990s and for Nokia after 1989 - which indicates that internationalisation does not always move in the same direction. Further research is needed to link these observations to enterprise strategy and history; it may be the result of a re-organisation, or mirroring the decline of specific technologies associated to a location. Reger (2003), for example, describes how periods of centralisation and decentralisation have been altered in the history of Philips' corporate R&D.

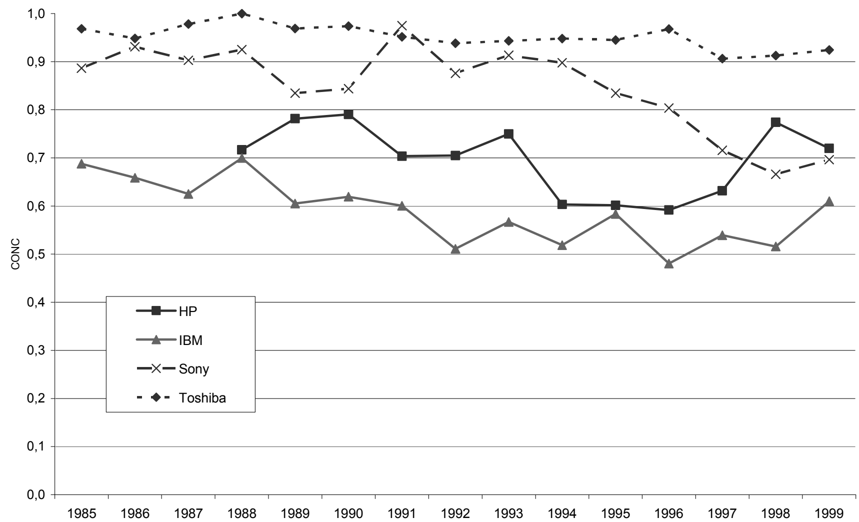
A similar picture emerges from the concentration indices of the Non-European companies. There is a moderate de-centralisation at IBM, Hewlett Packard and most clearly at Sony. These trends give no indication that the focus of corporate R&D has moved away from their home countries. This is most salient at Toshiba - where virtually no change in concentration can be observed through the whole period. The development of Toshiba mirrors the development of Philips, but at a much higher level of concentration. Having the similarities in products between the two companies in mind, these results are a clear indication for the influence of corporate strategy and the underlying national system of innovation on internationalisation strategies in R&D.

The vast differences in the internationalisation patterns between firms of the same industry suggest that the goals, motives and strategies associated with the internationalisation of innovative activities are highly firm-specific. Therefore, further research should try to match the evidence from patent data with the results of interviews and case-studies.



Source: OECD Triadic Patents database, own calculations

Fig. 54. Geographic Concentration of ICT Patent Inventions of Nokia, Philips, Siemens and STMicroelectronics, Priority Years 1985-1999



Source: OECD Triadic Patents database, own calculations

Fig. 55. Geographic Concentration of Patent Inventions in ICT of IBM, Hewlett Packard, Sony and Toshiba, Priority Years 1985-1999

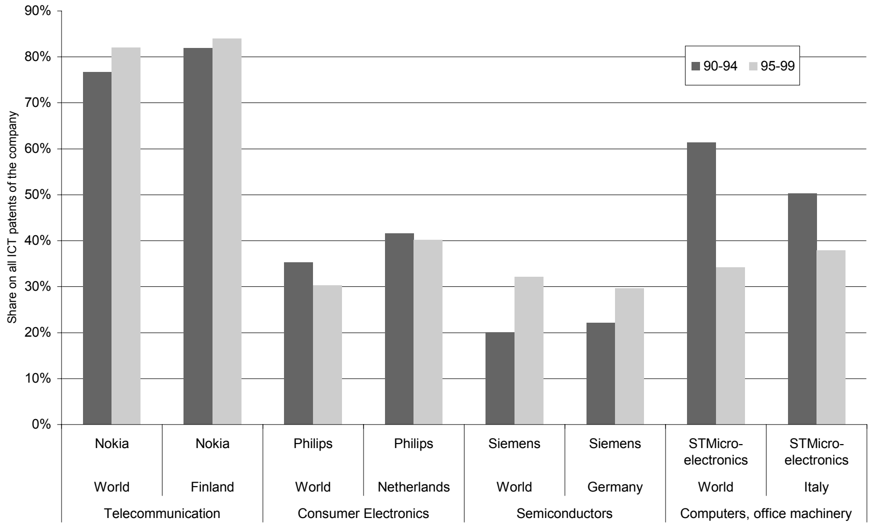
3.4 Technological Specialisation at Home and Abroad

We now combine the analysis of concentration at the level of technologies with the geographical patterns of patent inventions of companies to see if the companies are specialized in different technologies at home and abroad. If a firm specializes in the same technologies at home and abroad, this is an indication that the firm follows a HBE strategy, while different specialisation patterns point to HBA where firms try to accumulate knowledge abroad not available at home. A different specialisation pattern at home and abroad may also point to an internal organisation in dispersed "centres of excellence" with their own distinct core competencies.

Figure 56 shows the relative shares of the main technological field at home and at all other locations of the companies. With respect to technologies, the eight companies investigated in this chapter have quite different fields of specialisation, whereas Philips, STMicroelectronics and Siemens are more diversified than Nokia. Nevertheless, all companies show similar specialization trends at home and abroad. In all cases, international expansion has hardly altered the degree of specialisation in the core technology. The companies basically do the same at home and abroad.

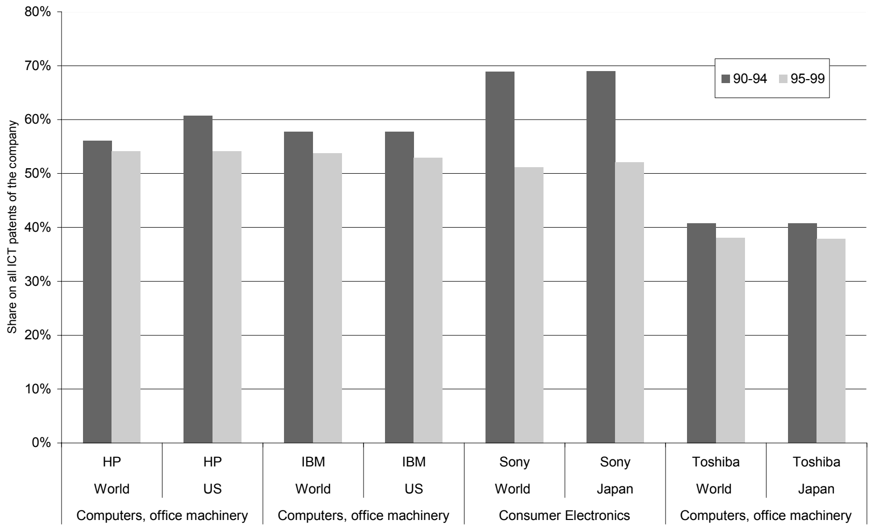
This is an indication that these companies follow a HBE strategy, where development activities abroad are linked to and largely based on the results of research at home. It is also obvious that both locations at home at abroad, have followed the same strategy with respect to technological specialisation and diversification. The similarities between world-wide and domestic research activities are even stronger in the non-EU enterprises, which all exhibit relatively high degrees of concentration. The only company where foreign and domestic research differs with respect to their specialisations is Phillips, which is also the most internationalized company in the sample.

We may conclude from the analysis that the companies studied above performed R&D and other innovative activities at more locations at the end of the 1990s than 10 years before that. Technological specialisation has remained nearly constant despite geographical decentralisation. This shows that the firms have nearly the same technological specialisation at home and abroad. It follows that geographical concentration must have been decreased in the 1990s, which is the case for the three companies.



Source: OECD Triadic Patents database, own calculations

Fig. 56. Main Field of Research Abroad and at Home of Nokia, Philips, Siemens and STMicroelectronics Priority Years 1990/94 and 1995/99



Source: OECD Triadic Patents database, own calculations

Fig. 57. Main Field of Research Abroad and at Home of IBM, Hewlett Packard, Sony and Toshiba, Priority Years 1990/94 and 1995/99

3.5 Recent Developments in the Internationalisation of R&D

3.5.1 Internationalisation of Research and Development in Asia and the EU10 Countries

The previous sections have shown that there is a tendency of European firms to diversify research and development activities away from the home country to locations abroad and mainly to the US. We explained this development by the need to support market exploration with overseas R&D units and the wish to access superior technology from foreign sources.

We will now examine recent developments in the internationalisation of research and development with the latest data from the European Patent Office (EPO). Compared to Triadic patent data, there is a bias towards European inventors in this data which may lead to an under-representation of the US and Japan. This disadvantage is compensated by the fact that the data used in this section include the latest patent applications at the EPO – which are not included in Triadic patent data thus far.

The expansion of European research to the US has been accompanied in recent years by increasing R&D activities of European companies in Asia and Eastern Europe. Companies investing in these countries are attracted not only by market access, well-trained engineers and scientists in India, China and Eastern Europe - who offer comparable expertise to that of their US or Western European colleagues at considerably lower cost. Cost differences have led to fears that high-skilled jobs in research and development are in danger of being relocated to these countries.

Recent research results seem to support the view that this relocation of research and development activities has already begun. A recent survey by the Association of German Chambers of Industry and Commerce (DIHK) reports that a third of all German enterprises already invest in research and development activities abroad and nearly half of these enterprises have in turn reduced their R&D efforts in Germany (Rose and Treier, 2005, p. 8, 10).

Dalia Marin (2004) conducted an extensive survey of German and Austrian subsidiaries in Central and Eastern Europe, South-Eastern Europe, and the Commonwealth of Independent States. Her findings indicated that 15% of all employees at German and 12% at Austrian subsidiaries in the target countries of the survey work in R&D. Both Austrian and German subsidiaries in this region already exhibit a higher skill intensity than their parent companies (Marin, 2004, Tables 10 and 11).

There is also an evidence vis-à-vis intensified R&D activity of European companies in China. Von Zedtwitz (2004) identified 199 distinct foreign-owned R&D centres established by foreign companies in China in early 2004 (most of them set up in 2002 and 2003, however). He cites other sources that speak of more than 400 (Von Zedtwitz, 2004, Table 1). Jiatao Li and Deborah Yue report 378 foreign R&D labs (Li and Yue, 2005, Table 1), similar numbers are also presented by Motohashi (2005).

Is corporate research and development already leaving the EU 15 for Asia and the EU 10? We will answer this question with patent data on foreign inventions applied for by EU 15 companies. The hypothesis tested in this section is relatively concise: if EU 15 enterprises already carry out extensive R&D activities in EU 10 and the CIS countries or Asia, we should find a large number of patent inventions by Czech, Hungarian or Russian citizens applied for by EU15 companies. A similar hypothesis can be formulated for Asian countries.

3.5.2 Results From EPO Patent Applications

The proposition that EU 15 enterprises already do extensive R&D activities in the EU 10 states, CIS and/or Asia is tested with patents filed with the EPO. The data employed in this section includes only applications between 2000 and 2005 regardless if the patent has been granted or not. The sample includes all applications published until January 1st 2006 by EPO. If the inventors of a patent application are located in two different countries, we count fractions according to the number of inventors[5]. Patents are counted by their priority date which denotes the first filing of a patent in any country worldwide. The priority date is therefore closest to the invention date (Hinze and Schmoch, 2004). Patent applications are published by the EPO within 18 months after the date of filing or the earliest priority date (EPO, 2004, p. 35). The number of patents for 2004 and 2005, therefore, is considerably smaller than in the previous years.

Like in the Triadic data set, there is also a clear trend towards R&D internationalisation among EU 15 members in EPO data, although the majority of inventions still originate from the home country (Figure 58). We find the largest shares of inventions from outside the EU 15 among some small member countries such as: Luxemburg, Ireland or the Netherlands. With the exception of Luxemburg, there is no country where ex-EU 15 inventions accounted for more than 15% between 2000 and 2005. If we keep home country inventions aside, there is no country that invents more patent applications outside of the European Union than inside the EU. This indicates a high integration of corporate R&D within the EU 15.

If we look at the EU 15 as one single entity (Figure 59), we find that only about 5% of all patent applications have been invented outside the EU 15. This share has been remarkably stable during the years 2000 – 2005. Patent inventions from outside of the EU 15 applied for by EU 15 companies predominantly originate from North America. Inventions from European countries not being members of the EU 25, predominantly originate from Switzerland and Norway. This confirms the finding from the previous sections that the internationalisation of European R&D is predominantly and an extension of R&D activities in other European countries in the US.

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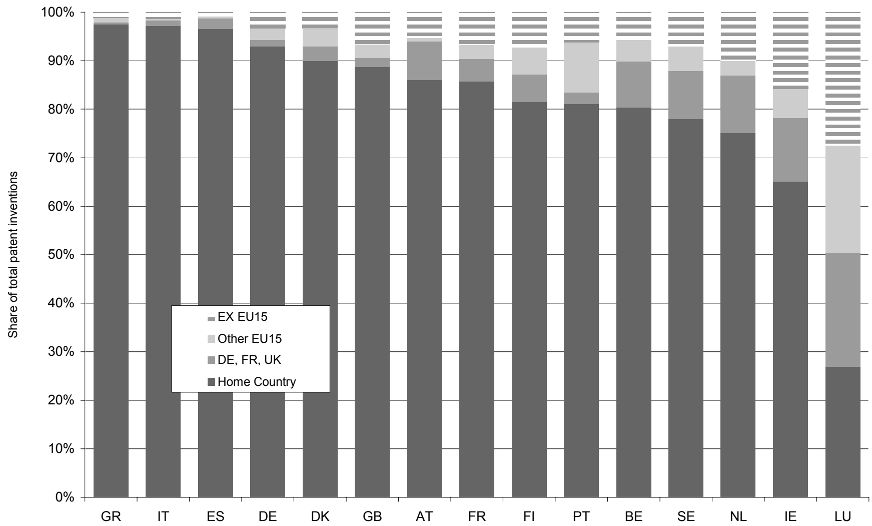
[5] If, for example, a patent refers to a Czech and a French inventor, the patent is counted 0.5 for Czech Republic and 0.5 for France as inventor countries.



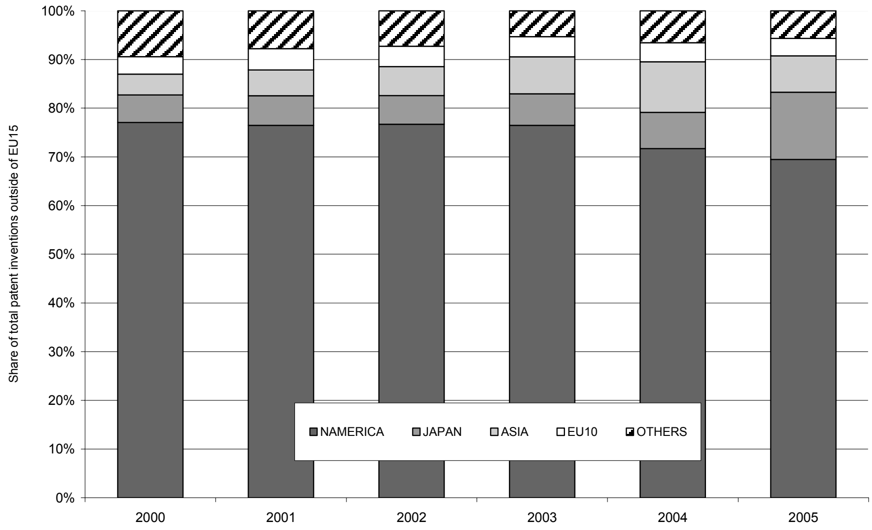
Source: European Patent Office, own calculations

Fig. 58. Geographical Distribution of EU15 Patent Inventions, EPO Applications, Priority Data 2000-2005

Figure 59 indicates that the shares of Asian locations are increasing steadily. This supports the observation that European companies have started R&D activities in this region in recent years. However, the share of patent inventions from Asian countries and Japan on total number of EU 15 patent inventions does not exceed 1% in any year between 2000 and 2005. The shares of patents invented in the EU 10 countries and the CIS are even smaller. This indicates that the importance of technological knowledge originating from these countries for Europe's companies is still very limited.

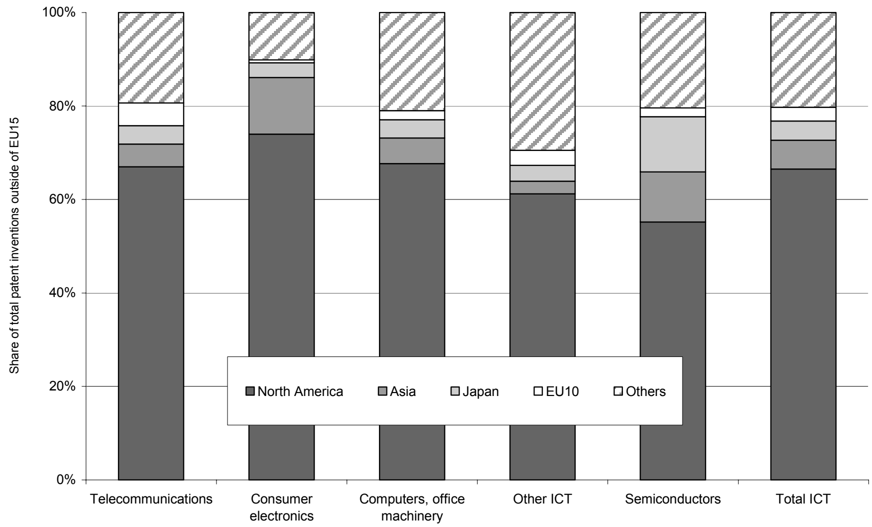
This picture changes slightly if we examine the level of technologies. 93.3% of all EU 15 patent applications at EPO - which specified information and communication technologies - were based on inventions from within the EU 15. We see a certain decrease of the EU 15 share between 2000 and 2005.

This shift, however, is mainly in favour of North America and cannot be applied to Asian countries. Countries outside the EU 15 states can gain the highest shares in consumer electronics, where they account for 11% of all ICT patents applied for by the EU 15. However, the deviations from the average value for all ICT patent applications reported above are quite small. If an EU 15 patent application in ICT is based on an invention from outside the EU, chances are very high that it originates from North America. The share of Asian and EU 10 locations, again, is small. However, it seems that Asian locations gained some importance in semiconductors and consumer electronics where they account for about 10% of all ex-EU 15 patent inventions.



Source: European Patent Office, own calculations

Fig. 59. Ex-EU15 Inventor Countries of EU15 Patent Applications, 2000-2005, European Patent Office



Source: European Patent Office, own calculations

Fig. 60. Ex-EU15 Inventor Countries of EU15 Patent Applications, 2000-2005, European Patent Office

3.5.3 R&D Without Patents?

The empirical evidence presented in this section suggests that current discussions about a relocation of R&D activities to Eastern Europe and Asia largely overstate the real magnitude of the phenomenon. Patent data do not deliver evidence for large-scale R&D activities of EU 15 companies in Eastern Europe or Asia. European multinational enterprises internationalized their R&D and innovative activities considerably during the 1990s. The most important host countries for these overseas activities, however, are clearly not in Eastern Europe, the CIS or Asia, but in Western Europe and North America.

How can we explain this obvious contradiction between patent data and the results of empirical studies cited above? If we take into account some common sense limitations of patent data (Griliches, 1990; Patel and Pavitt, 1995), there are two explanations:

- First, R&D does not necessarily lead to a patent. R&D productivity varies between different locations. Companies utilize inputs for R&D more or less efficiently and the propensity to patent varies between industries and countries.
- A second explanation relates to the goals of foreign-sponsored R&D in these countries. If these activities mainly focus on adapting existing products to local needs and supporting local production for the host markets. They may yield only very few inventions worth to be protected by an EPO or Triadic patent. We have described such a strategy as 'Home-Base Exploiting'. (see the previous section of the chapter).

Can these factors explain the apparent differences between the results of our analysis, the public recognition of outsourcing and the results of surveys discussed above? We think, they can explain them at least partly.

EU10, but also Asian countries exhibit considerably lower patent intensities[6] than Western Europe and the US. Figure 61 shows how these differences vary between countries. A triadic patent from China requires a much higher input of R&D expenditure than one from Western Europe[7]. These differences may point, among other factors, to an overall lower productivity of scientists and engineers in these countries.

The ratio of R&D expenditure per patent also points to the second reason, the motives of foreign R&D. There is evidence that Western companies in Asia and EU 10 often follow HBE motives. Motohashi (2005) finds in an analysis of corporate R&D in China that 'market driven' dominates over 'technological driven' or

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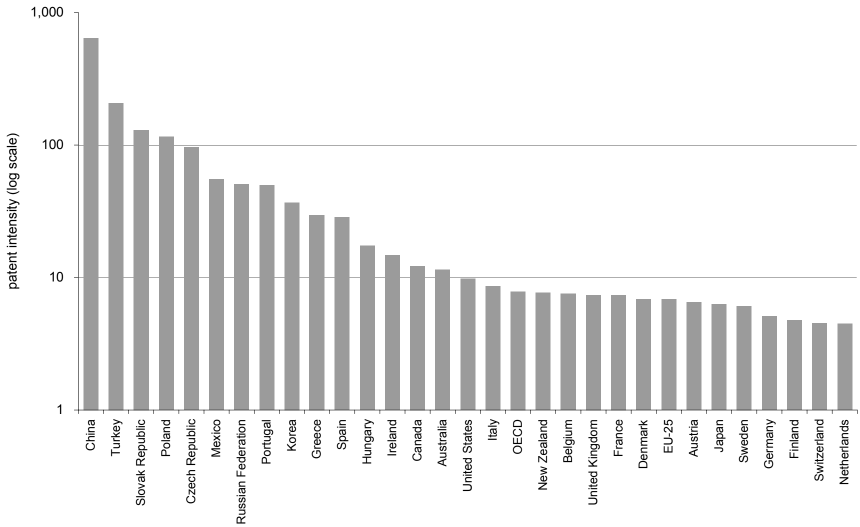
[6] Patent intensity is measures by the ratio of the number of triadic patent inventions and gross domestic expenditure on research and development financed by industry, millions of US$, using purchasing power parities for the year 2000.

[7] A similar picture is delivered by a comparison of scientific publications related to public R&D expenditure A publication from Russia or China, for example, receives only a forth of the number of citations than a publication from the US, see http://in-cites.com/countries/2005allfields.html#Citations

'human resource driven' motives. Nokia and Motorola, for example, put large efforts in adjusting their products to the Chinese language (Li and Yue, 2005).

If companies mainly adjust their products to foreign markets via overseas R&D, they may not find it worthwhile to protect their R&D results by EPO or Triadic patents. Instead, they would seek patent protection in China first. There is indeed evidence that foreign companies are very active at the Chinese Patent Office (Sun 2003; Sun 2004). This would also mean that innovative activities in Asia and Eastern Europe are rather a complement than a substitute for R&D in Germany and Austria and there is no outsourcing in a strict sense, but rather an increase of overall R&D capacities of the enterprises. Radical inventions and new products to be exploited in Europe or on a world-wide scale are still developed in Europe and the US.

Our results do not imply that the countries in question will never develop into important locations for R&D (within the EU 15) countries. Since Eastern Europe and Asia are main target countries for FDI of EU 15 companies, it seems very likely that these companies will also build up R&D capacities there. This, however, takes time since corporate innovation processes are inherently uncertain, complex, and cumulative and characterized by continuing interaction with the firm's environment (Pavitt, 2005). Therefore, many engagements in foreign-located R&D of EU 15 companies today may be mainly seen as HBE and a commitment to the host country; however, in the future we will envisage rising shares of these countries in the portfolio of R&D locations of EU 15 enterprises.



OECD Triadic Patents database, Main Science and Technology Indicators, own calculations

Fig. 61. Patent Intensity: Industry-Financed R&D Expenditure per Triadic Patent Invention, 1991-2001 Average

4 Main Findings and Conclusions

The data analysis has shown that the degree of internationalisation in innovative activities is rising; however, it is still well below the intensity of internationalisation we can observe in sales or production. Even the most internationalized companies are still strongly rooted in the innovation systems of their home countries.

The theoretical literature has identified two main motives for enterprises to perform overseas innovative activities. The first motive is the need to adjust products to the local needs of foreign markets and to provide global development services for customers. This motive is connected to scale intensive sectors. The second one is the wish to access superior knowledge and locate research and development units where systems of innovation provide superior framework conditions, a motive we may predominantly find in knowledge intensive sectors of ICT. Empirical evidence shows that the first motive is prevailing; however, it is always a melange of reasons and motives that determines firms to go abroad with innovative activities.

We have shown that concentration in ICT research and development has decreased in the 1990s in the member countries of the EU 25. Today, R&D in ICT is more equally distributed over Europe than 10 or 20 years before. The strongest deconcentration could be found in telecommunications, which is largely due to the rise of the Nordic telecommunications industry.

We analyzed the geographical patterns of patenting activity of eight companies, four of them European. It turned out that the share of the home country on total R&D activity decreased in all cases. All European companies increased the share of ICT patents invented in the US as well as in other European countries. Moreover, we observed that US firms increasingly conduct innovative activities in Europe.

Despite large investments of European and US companies, locations outside the Triad, in particular China or India, but also the EU 10 countries yielded only few ICT patents thus far. Overall, the patent analysis indicates that leading edge R&D in ICT is still concentrated largely in the US and Europe. We argue that overseas R&D in these countries is mainly 'Home-Base Exploiting' (HBE) focussing on developments for local markets, instead of 'Home-Base Augmenting' (HBA). Strategic R&D is still concentrated in the home countries of the enterprises.

Our observations fit in the classification of ICT activities proposed in Chapter 1. R&D activities as an example of highly knowledge-intensive activities (i.e. Quadrants I and II) still tend to be concentrated in the US and Europe. The intangible character of much of ICT facilitates and enables a fragmentation along the value chain. The extent to which this process of fragmentation can be observed distinguishes ICT from other sectors. However, in order to ensure that the most knowledge-intensive segment of the ICT value chain remains in Europe, a permanent effort to stay at the leading edge is needed and favourable conditions for conducting R&D need to be offered.

CHAPTER VI. From Case Studies: International Division of Labour Within ICT Companies

Rene Wintjes

1 Business Case Studies, Objective and Methodology

The eighteen business case studies complement both the theoretical and the other empirical work by providing detailed and recent insights on the adopted internationalisation strategies, and the implications for the international division of labour at the level of individual EU based ICT companies. The objective of the case studies is to illustrate and complement the theoretical and practical understanding developed in this study. The analyses mentioned above leads to insights mostly at the macro- and meso- level of countries and sectors, or to insight focussing on R&D as one business function indicated by patent applications. We have adopted a qualitative methodology to address geographical fragmentation (and organisational integration) of ICT activities at the micro-level, that is, the company level, but also below the level of a MNE, given that some of the case studies focus on a specific EU-based subsidiary of a multinational corporation.

A two-stage work plan was adopted to perform case studies. In the first stage, eighteen business cases were reviewed in an explorative way so as to get a broad view on the emerging key issues. These eighteen companies have been selected to reveal different models of internationalisation, since these differences may have different policy implications. In order to get this desired diversity we have included:

- both small and large companies;
- companies from each of the three ICT sub-sectors of hardware, software, and services;
- companies located in the West, East, South and North, to have EU-wide coverage;
- companies with R&D activities in NMS; and
- companies with FDI/subsidiaries located outside the EU.

In the second stage, we focused on a smaller selection of cases in order to get a more detailed and in-depth view on internationalisation of five ICT companies located in Europe, namely: AS&T, LogicaCMG CEE, SAP, Océ and FreeSoft (see the table below and Annex E).

	Name	Location	Nationality of ownership	Large / small firm
1	**ITProvision**	Belgium/ Romania	Belgium/ Romanian Joint Venture	Medium (about 70 people in Romania)
2	**Infineon Austria**	Austria	German, mixed	Large
3	**AT&S**	Austria	Austrian	Large
4	**T-Systems (Deutsche Telekom AG)**	Germany	German	Large
5	**FreeSoft**	Hungary	Hungarian	SME, 100+
6	**SAP**	Germany	German	Large
7	**Kring Technologies**	Denmark	Danish	MNE-SME 15 people in Denmark, 130 global in total
8	**ELMOS Semiconductor AG**	Germany	German	Large, 960 empl. Globally
9	**SAP Labs Bulgaria**	Bulgaria	Germany	Large MNE; SME-subsidiary of 190 people in Sofia
10	**Delta Singular**	Greece	Greek	1500 in total
11	**Océ**	Netherlands	Dutch	Large
12	**OMRON Manufacturing of the Netherlands**	Netherlands	Japanese	SME-subsidiary
13	**Xilinx**	Ireland	USA	2,600 worldwide 400 in Dublin
14	**CertiCon**	Czech Rep.	Czech (at least part)	SME
15	**Logica CMG Prague Development Centre**	Czech Rep.	UK/International	Large MNE, SME subsidiary
16	**Videoton**	Hungary	Private Hungarian (former state-owned TV-Set-producer	Large (8000 people in Hungary, 1000 in Bulgaria)
17	**Tumbleweed Communications**	Bulgaria	USA	Large MNE, local SME subsidiary of 100 empl.
18	**F-Secure Corporation**	Finland	Finnish	

	Name	ICT Activity	R&D activity in NMS	FDI outside EU	Note
1	**ITPro-vision**	Organises 'near-shoring' in Romania and sales of software	Yes	No	
2	**Infineon Austria**	headquarter for hardware automotive electronics	New large site in Dresden	Yes	has its own internationalisation strategy
3	**AT&S**	manufacturer and developer of printed circuits for mobile phones	No	locations in Austria, India and China	
4	**T-Systems (Deutsche Telekom AG)**	Telecom services			
5	**FreeSoft**	Electronic customs management services	Yes	Yes, in Germany and US	After growth by take-overs thinks about how to enter Brasilian and Chinese markets
6	**SAP**	Software/services	Yes	Yes	
7	**Kring Technologies**	Customized IT services	Plans to have a development unit in NMS in 2005	India, and exploring options for Ukraine, China, Belarus, etc.	Works with Nikia, Intel, Sony Ericsson
8	**ELMOS Semiconductor AG**	Development, production and marketing of tailor-made application-specific integrated system solutions based on semiconductors		Yes, in the US	subcontracting of packaging and assembly in the far-east
9	**SAP Labs Bulgaria**	Software development 180 people in Sofia R&D office; Innovative software for J2EE SAP Web Application Server	Yes, Bulgaria	Yes, many	Fastest growing subsidiary of SAP
10	**Delta Singular**	Software Products IT Outsourcing Services Systems Integration (100 in R&D)	No	Yes	Basically a collection of many small service companies
11	**Océ**	R&D, Manufacturing and services of digital copymachines and document handling	Hardly, only small software subsidiary for software in Romania	Yes, sales offices in many countries	Shifted assembly to Czech Rep. Company is transforming to services:
12	**OMRON Manufact-uring of the Nether-ands**	R&D, manufacturing and services industrial measurement and control systems	No, as far as known by now	Yes, e.g. new plants in China	Strategy of EU sourcing, Centre of Excellence. within corporation in wireless technology

13	**Xilinx**	EHQ, Semi-conductor supplier, increased R&D activities, engineering and production. By teaming with technology leaders in silicon fabrication, design automation, system level tools, IP, and design services	No	Global, e.g. European HQ in Dublin, Asian headquarter in Singapore	500 more jobs (mostly in research) in Dublin over the next 4 years
14	**CertiCon**	Software development	Yes	No	Originally a R&D spin-off from Academia of Science
15	**Logica CMG Prague Development Centre**	Software development in Prague. The company employs around 21,000 staff in offices across 35 countries and has more than 40 years of experience in IT services.	Yes		Headquartered in Europe, LogicaCMG is listed on both the London and Amsterdam stock exchanges
16	**Videoton**	a privately owned Hungarian Contract Electronics Manufacturer (CEM), the largest independent Electronics Manufacturing Services (EMS) provider in the CEE region, in TOP 30 worldwide	Yes	Not yet, but new plant will be located in Ukraine	Small marketing office located in Germany
17	**Tumbleweed Communications**	Software, services; Since 2002 provider of business solutions: anti-spam, anti-virus, e-mail filtering, and e-mail encryption	Yes, Bulgaria	Yes	sold Indian (Bangalore) operation to expand the existing business and R&D operations in Sofia
18	**F-Secure Corporation**	Products include anti virus, network encryption, desktop firewall with intrusion prevention, anti-spam and parental control. Founded in 1988, F-Secure has been listed on the Helsinki Exchanges since 1999. The headquarters is in Helsinki, Finland	No	offices in the USA, France, Germany, Sweden, the United Kingdom and Japan.	

* these case studies are performed by: Bernhard Dachs, ARC Systems Research, Vienna; Michael Vogelsang, EIIW, Wuppertal; Paul Welfens, EIIW, Wuppertal; and René Wintjes, UNU-Merit, Maastricht

2 Analysis on ICT Sub-Sectors of: Software, Hardware and Services

Looking more closely at several companies from the three ICT sub-sectors might perhaps tell us if, for instance, software companies use a specific internationalisation model. We will focus separately on the software sector, because in theory they are the most footloose, especially when the products of the companies have a 'digital good' characteristic (see Appendix A.I). When considering the ICT hardware producers, the more traditional concept of internationalisation could still apply. In this case, the question is mainly based on which functions remain in the EU, because given the results derived from the literature review (see Chapter 2) we could already expect that the EU as a location for cost-efficient manufacturing is loosing ground.

2.1 Software Companies

Three cases have been addressed with respect to software: SAP as the largest European Software Company, F-Secure as a specialized producer of software, and FreeSoft as a service provider for a broad range of software development and IT services. All three companies are listed at stock exchanges, respectively in Germany, Finland, and Hungary.

When comparing the strategies of these three companies, one can determine that the internationalisation strategy depends on the type of products, especially the scalability and the service-intensity of the products, which can be translated into the two dimensions of scale-intensity and knowledge-intensity. SAP is the most advanced in its internationalisation, and FreeSoft is just in the beginning of this process, however, because it also offers services, their internationalisation to a large extent, will not take off as fast as it did for the other two software producers.

SAP offers Enterprise Resource Planning (ERP) systems, which include a variety of additional software components such as Customer Relationship Management (CRM), Supply Chain Management (SCM), among others. The service intensity of the SAP platform is high: 120, 000 software companies and consultants implement SAP systems in over 120 countries. This means they adapt the SAP system to the special needs of the client or the sector. Nevertheless, the scalability of the SAP system itself is high. Comparing the 2005 financial results, SAP shows the highest rates of revenue per employee and EBT (earnings before tax) per employee of the three companies covered.

F-Secure provides antivirus, network encryption, desktop firewall, anti-spam and parental control software. In the beginning, F-Secure sold its products only via Internet (download) and by CD (box-Solution). Since 2004 their strategy has changed: now Anti-Virus solutions are bundled with additional services which require a local presence in international markets. The new strategy is called 'security as a service'. Additional services are, for example, consultation on network, security and organisational concepts and gateway solutions. The products and services of F-Secure are offered by resellers and distributors in over 50 countries.

FreeSoft offers a range of software and internet products and services including, document management solutions (for governments), custom applications, mobile, e-commerce, multimedia, data entry, and ERP implementation. Subsidiaries are located in Germany and US, where they have been offered outsourcing solutions for developing customs applications. Meanwhile the strategy has changed from a price competition strategy to a strategy that sells specialized knowledge at high margins. However 93 per cent of revenues have still been generated in Hungary in 2005. This is the strongest home-bias of the three companies: F-Secure generates 36 per cent of revenues in Finland and Scandinavia and SAP realize 21 per cent of its revenues in Germany.

In the **theoretical** review (see Appendix A.I), the following two approaches with respect to digital goods are presented: the administration rights approach in combination with the general equilibrium approach of Antras (2003) and, a general equilibrium model which is opened for aspatial digital companies located in 'rest of the world'. The two models show that different internationalisation strategies might prevail in the sector of digital goods. The key driver for internationalisation in the first model is one that is used to accompany multinational companies going into foreign markets or to support outsourcing solutions. On the other hand, the second model predicts that the search for new markets for the digital good producer itself is the key driver of internationalisation. Both constellations have different consequences for a company's strategy, e.g. regarding the goals retaining the market leadership or the R&D-intensity. The analysis of the three case studies provides anecdotal evidence on the prediction that there exist different internationalisation strategies for digital goods producers, depending on the knowledge-intensity and scale-intensity of the products.

When **comparing the strategies** we first point out that the products of SAP and F-Secure are knowledge intensive and scale effects are important. Consequentially the internationalisation strategies of both companies show common strategic goals such as:

- Linking scalable products with high-margin services;
- Becoming / Remaining No. 1 in market segment worldwide;
- Technological leadership matters. High investment shares in R&D;
- Internationalisation pattern: first to find a local partner (reseller) for service and distribution; and then, if the local partner is successful, to ensure own presence a subsidiary is established in this country.

A difference between SAP and F-Secure is the original starting point of internationalisation: SAP accompanied multinational enterprises first, F-Secure has used the internet to offer products worldwide. FreeSoft products show high knowledge-intensity, but have only low economies of scale. Therefore its internationalisation strategy is different from that of SAP and F-Secure: FreeSoft offers its own labour-intensive competencies as services, and targets selected markets.

The future international targets of the companies reflect the differences in strategies and the global position achieved today: SAP's next goal is to strengthen its position in China and India, and F-Secures' international targets are in Europe and Asia in general. FreeSoft wants to enter the market of governmental document management systems in China and India in particular, because they presume a lack of domestic competence in this field. Offering knowledge-intense products to gain higher margins is a common feature of all three companies; however, they vary in their internationalisation strategy due to differences in the economies of scale.

2.2 ICT Hardware Companies

Several of the case study companies can be labelled as ICT hardware companies. However, immediately the diversity in the extent to which the activities really relate to manufacturing is striking and sheds a light on the position of the EU with respect to manufacturing.

Videoton is a Contract Electronics Manufacturer (CEM) and the largest independent Electronics Manufacturing Services (EMS) provider in the CEE region, ranked in the TOP 30 worldwide and TOP 10 in EU. Videoton gains outsourcing contracts, mainly from Western European countries, and produces, for example, fax-machines, TV sets, TV set-top boxes and different kinds of household appliances. Production is located in Hungary (8000 employees) and Bulgaria (1000 employees). A small office for marketing is located in Germany. An additional production plant in the Ukraine is planned. Relatively low labour costs are one of the reasons why the investment pattern of Videoton directs to the east. Products (e.g. cable loops) which were produced in Hungary ten years ago are now being produced in Bulgaria. Standard electronic components are imported from Asian companies. Overall Videoton's management expect a threefold division of labour: West-Europe will specialize in design, development, marketing, distribution, Middle-Europe (EU10) will specialize in engineering and development, and Eastern-European countries in labour-intensive production.

At the other end, **Océ** can hardly be labelled as a manufacturing company any longer. While Océ is probably still listed in the statistics under manufacturing industries as a producer of office machines, the fact that only 10% of its total employees (against 22% in 1997) represented employment in manufacturing and logistics in 2005, suggests that Océ is rapidly entering the service economy. Océ now supplies a wide range of products, software, and services for copying, printing and digital document management. Software has become the major discipline in Océ's research and development, which is mainly concentrated in Venlo (the Netherlands). Out of the 24,000 employees worldwide, approximately 4,000 work in the Netherlands.

In the figure below, the activities of Océ are plotted according to the scale-intensity and the knowledge-intensity. The knowledge intensive activities are dominant in the Netherlands and the EU. The less knowledge intensive business functions concern the production of parts and components which have experienced a high level of outsourcing. Increasingly the parts and components originate from Asia. Relatively low knowledge-intensive and low scale-intensive activities that are still performed at Océ, refer to a large extent to the sales and service activities at the many offices around the world. The service and maintenance contract are however very profitable, moreover, the information coming from direct interaction with clients is of strategic importance to the R&D core at Venlo.

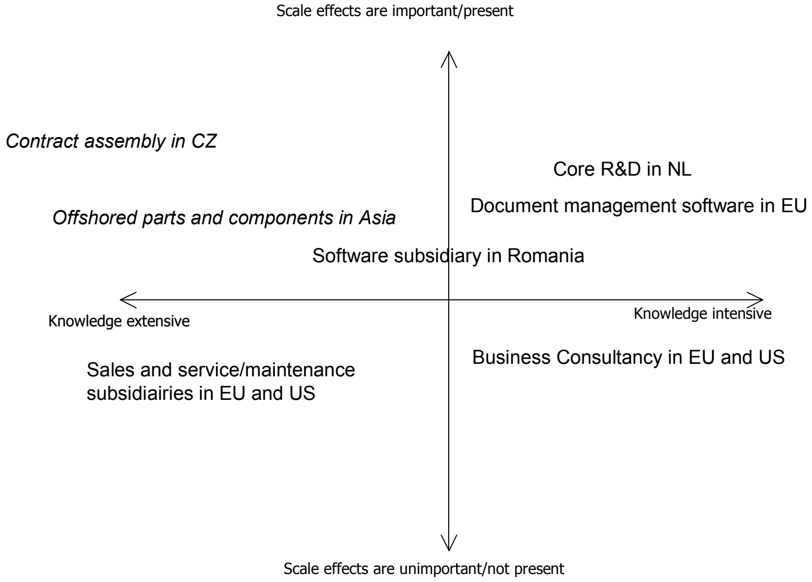


Fig. 62. Activities of Océ Plotted along the Dimensions of Scale and Knowledge

The Austrian company **AT&S** is somewhere between Videoton and Océ.

The expansion to Asia, however, will also lead to a new division of labour within the company. In the future, AT&S will concentrate small-lot, niche production, prototyping and tailored design activities in Europe while mass production will move to Asia. An example of such niche products is the engine control system PCB ordered by Airbus. Despite its international organisation of production, the company's R&D activities are deeply rooted in the Austrian Innovation System, as can be seen from AT&S' co-operation network

(See in-depth case study AT&S in Annex E)

2.3 ICT Services Companies

Overall the ICT service companies are basically more market-oriented and the activities are decentralised because for most activities, interaction with customers is essential. However, all of the service companies we interviewed distinguish between activities according to the extent that they can be outsourced and/or internally or externally off-shored. Small firms like ITprovision and KRING technologies include off-shore possibilities in their offering of services to local clients in Belgium and Denmark, respectively.

Larger service providers such as LogicaCMG are truly global networks which offer economies of scope. While the Product Development Centre of LogicaCMG CEE in Prague is specialised and has its product responsibilities in wireless technology, the rest of LogicaCMG CEE has a market responsibility and offers the whole range of LogicaCMG's sector-specific as well as cross-sector offerings. For any offering they can involve other LogicaCMG offices and vice versa, CEE offices are involved in offerings of their globally located 'sisters' according to the Blended Delivery Model, which is a concept that combines on-site, on-shore, near-shore and off-shore activity within a global corporate network of offices and locations. Again, we cannot plot all the activities of LogicaCMG CEE in one box (see figure), however we can determine that the trend is towards the more knowledge intensive activities in Europe.

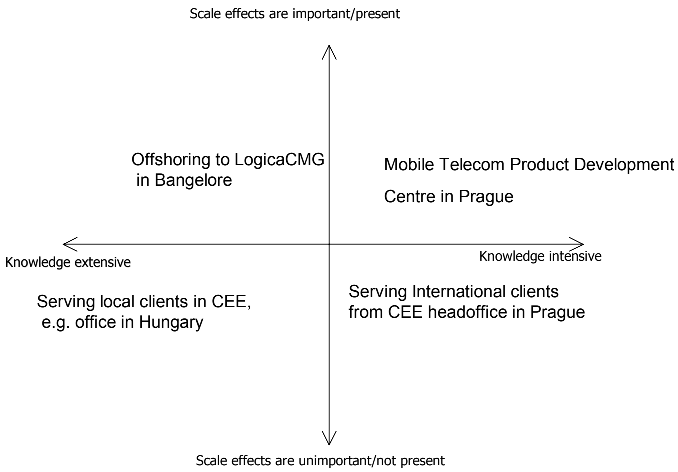


Fig. 63. Activities of LogicaCMG CEE Plotted Along the Dimensions of Scale and Knowledge

3 Motives and Models of Internationalisation

A horizontal analysis across the case studies has resulted in the conclusion that in the case of ICT companies a certain internationalisation decision is almost always a 'multiple-motivated' decision, combining mainly low-cost arguments, market development arguments, and strategic arguments. Take for instance the case of AT&S:

> *It became clear to AT&S at the end of the 1990s that the company had to expand its operations abroad for several reasons; first, market growth seemed to be higher in Asia than in any other part of the world. Second, production in Asia could make AT&S less vulnerable to exchange rate fluctuations. Third, production capacities in Austria had reached their limits and had to be expanded. Fourth, production costs in Asia are lower than in Austria.*
>
> *(See case study AT&S in Annex E)*

This observation agrees with the OLI paradigm (combining Ownership-, Location-, and Internalisation-advantages) which is basically an eclectic conceptual model used to address this multiple motivated nature of internationalisation decisions (see also Chapter II 2.4).

Another clear message from the case studies is that the individual internationalisation decisions are clearly linked to former decisions which shows up in path-dependency and trajectories in time and space for ICT industries too. For instance, when asked for the reasons to start or increase R&D activities on a certain location, many interviewees have mentioned reasons referring to former experiences of any kind, e.g. an existing sales office.

> *The first reason is that both Logica and CMG already had established offices in Prague. Administrative structures were already in place and they had previous experience from off-shore projects for international clients.*
>
> *(See case study LogicaCMG CEE in Annex E)*

In this respect the case studies also confirm theories that emphasize the evolutionary nature with the process- or step- models of internationalisation (See also Chapter II, paragraph 3.2). However, the internationalisation process seems to be more dynamic for the ICT sector than for other sectors, especially for software companies (see the cases of F-secure and SAP). The 'digital goods' characteristics presented in the theoretical discussion fit with the observed internationalisation strategies of companies in the ICT software sector. Not only are these companies more foot-loose: they also have less restrictions in time, as they experience less limitations to implement fast internationalisation trajectories. Since Dunning originally presented his OLI framework in a static way, the more recent applications which adopt a more dynamic approach, are therefore more relevant regarding the ICT sector.

This is especially true for some cases of Foreign Direct Investments in New Member States which have also pointed to the fact that asset-seeking and asset-exploiting are not mutually exclusive motives for internationalisation.

In May 2004 Tubleweed (USA) announced moving out of India, closing down the former ValiCerts office in Bangalore. At the same time it extended the existing business operations in Sofia (Bulgaria) by 50 percent. Besides an increasingly important location for R&D Bulgaria has also increased importance as a market for Tumbleweed. To name one example, Bulgaria's leading GSM operator MobilTel has chosen Tumbleweed in 2005 to provide it with its MailGate E-mail Firewall to filter and secure email traffic.

(See case study Tumbleweed Communications Bulgaria in Annex E).

The cases of Tumbleweed in Bulgaria and LogicaCMG in Czech Republic illustrate that for globally networked companies, the motives and opportunities for growth 'abroad' are dynamic and systemic. Such co-evolution of explanations blurs the boundaries between the originally expected Ownership-, Location- and Internalisation- advantages. When applied to ICT industries, the OLI-framework must therefore be put into a dynamic, networked perspective.

Concerning the **Ownership-advantages** we have witnessed a decreasing importance of the nationality of ownership, e.g. in the case of SAP and LogicaCMG, Delta Singular. The terms 'home' and 'host' seem to become less relevant for many of the case study companies, and not only for the large globally networked companies but also for small companies like Kring and ITprovision, which are two companies that have developed a specific international business model in which they have integrated off-shoring and near-shoring possibilities. Concepts like 'home-base-augmenting R&D' and 'home-base exploiting R&D' seem rather out-dated for such international corporate networks of software and service providers. For instance, the R&D activities at LogicaCMG in Prague could perhaps be better labelled as network-exploiting or network-augmenting, depending on the specific project. The cases involving ICT hardware show a more traditional pattern that agrees with the observation that most R&D is still concentrated in the home-country near its headquarters.

Location-advantages remain very important in many case studies although they change over time and we have seen many cases where there is a constant 'competition between locations' within corporate networks, e.g. between Bangalore and Sofia, or between PaloAlto and Walldorf. Some illustrations:

… for some products manufacturing has been re-located to OMRON affiliates in China. Not only because it was cheaper, but also because OMN has increasingly focused on industrial markets, and industrial clients do not want standard applications.

(See case study OMN:Omron Manufacturing of the Netherlands in Annex E).

When considering the **Internalisation advantages** of the OLI framework, the ICT case studies highlight:

- the role of global networks of partnerships especially for software companies, e.g. in the case of SAP:

> *SAP has labs all over the world and tries to partner with other companies where SAP does not have a core competency or main focus. Co-innovation with partners and customers is part of the growth strategy. SAP has a unique partner ecosystem with more than 1,500 partners worldwide with overall more than 180,000 SAP partner certificates.*

- the increase of (external) off-shoring of the more standardised, codified, and less strategic tasks in software development and manufacturing, and
- the increased importance of contract manufacturing.

Large ICT service companies such as Delta Singular and LogicaCMG prefer internalised networking.

> *LogicaCMG CEE plays an important role in the so-called 'Blended Delivery Model' that combines on site, on-shore, near-shore and off-shore activity within a corporate network of offices and locations. "In theory, everything is offshore-able, but the extent is limited to the degree with which the client is comfortable". A system of Global Diliveray Services is used to decide what the best places and partners are to perform an assignment and for some activities that require more interaction and or intimacy the clients rather want to be served from a near-shore location, and not from a off-shore location.*
>
> *(See case study LogicaCMG CEE in Annex E)*

Small and medium ICT service companies more often adopt external networking strategies. But, overall, many different new business models have been developed, e.g. by ITprovision and KRING:

> *Kring Technologies is a young Danish multinational employing 130 people world-wide and 15 people in Denmark. They provide customized IT services and consulting to clients worldwide. "We offer Western project management and quality processes combined with low cost qualified technical skills through our offshore facilities in India and more recently the near-shore facility in the Ukraine.*
>
> *(See case study Kring Technologies in Annex E)*

4 International Division of ICT Business Functions, the Place of EU

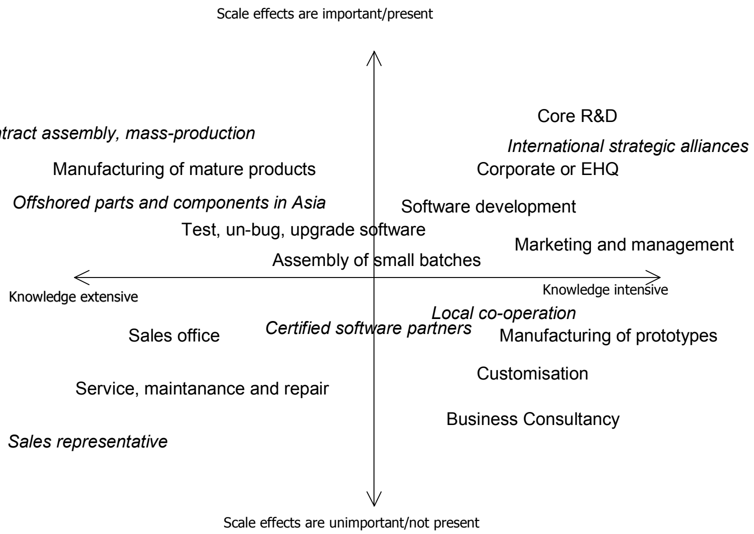
Fragmentation of production has been defined as splitting-up or decoupling of the value chain allowing for a more in-depth specialisation and broader international networking. The reason for these developments is that different stages of production correspond to different production functions so that a country may have a comparative advantage in one stage of production and a comparative disadvantage in other stages or functions. In the past, when the Marshallion single-plant-family-firm dominated the economy, international trade lead to specialisations of countries in certain products. In the business case-studies we have focussed on the geographical splitting-up of activities within ICT companies, in order to identify geographical specialisation in certain business functions.

Our **main conclusion** is that the case studies support the evidence based on the analysis of international trade at the level of sectors and products. We have found evidence for this geographical splitting up of functions in ICT industries within international ICT companies. When considering the place of the EU in the international division of activities within ICT companies, our main conclusion is that the activities in the EU15 tend to be relatively knowledge intensive, focussing on customisation and high quality. The functions and activities located in Asia tend to be the more standardised and codifiable activities. New Member States take a middle position in this international division of ICT functions.

FreeSoft is the largest Hungarian software company. The Budapest based company offers a full range of software of internet products and services. It relies on international networks, especially with Oracle, but also with other companies. Its internationalisation strategy may be described - in short- as: 'Develop products, not price competition'. This refers to the strategy on the German and US market especially, to win customers for its database conversion services convincing them by a high quality level and less by differences in labour costs.

(See case study FreeSoft in Annex E)

Summarizing the case study evidence, we have plotted the geographically fragmented business functions along the dimensions of scale and knowledge (see Fig. 64). We can associate several of the plotted functions with the three ICT subsectors of hardware, software and services. ICT hardware and digital goods are more standardised and codified and therefore more scale-intensive with more globalised markets than ICT services. The scale of production (that is, the cost-efficient advantage of geographical concentration) for ICT services companies is less important. Small service providers can therefore be very productive, but for ICT service industries, economies of scope are very important which can be obtained through international but often decentralised networks. However the evidence from the case studies extends the conclusion beyond the sector level, given we have observed the trend at company level across the three ICT sub-sectors. The typical slogan or mission of the companies in our study therefore does not refer to a specific product or service, but to solutions.



Note: Functions in brackets are external, not performed under full ownership
Source: based on the case-studies

Fig. 64. Business Functions Along the Scale and Knowledge Dimension

In almost all case-studies we have seen that the companies have included more parts of the value chain, most notably by extending or expanding into service activities, but there is also hardly any company that is not engaged in software development somehow. Internationalisation facilitates both **geographical fragmentation and corporate integration** of business functions.

Within this international fragmentation and integration the EU has specialised as a location for the more knowledge intensive business functions, ranging from core R&D to design and marketing & management, and from innovative software development, to customisation and business consultancy. This specialisation can not be maintained without internationalisation.

Concerning the fear for losing ICT jobs in the EU we can not draw firm conclusions based on 18 case-studies, but at least they do not confirm the justification of such fears.

CHAPTER VII. Policy Analysis and Policy Conclusions

Bernhard Dachs and Matthias Weber

1 Introduction

The ongoing internationalisation of production, investment, research and development activities in information and communication technologies poses serious challenges to policy. How should national as well as EU policy makers react to outsourcing of ICT production and certain types of services? Is there a danger that R&D units of European ICT firms are leaving their home countries for Asia? What is the likely impact of internationalisation on the competitiveness of European ICT firms? What further implications does the internationalisation process raise for innovation systems in Europe? Does Europe need a strong ICT industry in order to fully grasp the benefits of this process?

Answering these questions is crucial for setting priorities in future R&D policy, for designing institutions, and for training and education policies. Unfortunately, underlying causal relationships are difficult to identify and disentangle - since they may vary between European countries, as well as between individual member states and the EU in total. In this chapter, we restrict ourselves to developing the key policy dimensions of the internationalisation of ICT and outlining some possible reactions to this challenge.

Information and communication technologies play an important role in recent conceptions of science and technology policy because they contribute to economic growth and development in three ways:

First, ICT directly contributes to economic growth. ICT producing sectors grew faster than the total economy in most OECD countries in recent years (OECD 2004c, p. 35). A considerable part of the direct growth effects in ICT producing sectors in these countries came from exports. However, only a few countries in the EU, like Ireland, Finland, have an ICT sector that is large enough to affect overall growth of the economy significantly (OECD 2003a, p. 40).

A second, more indirect effect of ICT is related to productivity. The use of ICT can increase productivity in many sectors of the economy (Van Ark *et al.* 2002; OECD 2003b; see also chapter II in this report), this may be an even larger than the direct contribution in many countries with small ICT sectors. ICT, as a General Purpose Technology (see Lipsey *et al* 2005), finds application in almost all sectors of the economy and can help firms to increase their overall efficiency in combining labour and capital, also referred to as multi-factor productivity (MFP).

A third economic benefit from ICT use is through lowering transaction costs, and a more rapid diffusion of new ideas and technologies, which, in turn, promotes innovation. ICT has reduced communication costs dramatically, allowing organisational models of innovation, production and service provision that are geographically more dispersed than before. Firms are clustering into "virtual enterprises" along supply chains, where it is difficult to immediately identify the boundaries of the single enterprises. Moreover, the internet has brought about virtual communities, and their long-term effects on culture can only be vaguely anticipated.

In the next section, we will examine the effects of internationalisation on home and host countries. By building on the typology of ICT as developed in chapter II, it will be possible to go beyond the general pros and cons of internationalisation and discuss this issue with respect to the major types of ICT. We will also examine what determinants may influence the internationalisation of firms. This chapter draws on insights from the theoretical (chapter II) as well as the empirical (chapter III - VI) parts of the project, and it will also look at differences across the four major types of ICT. The final section aims at highlighting the key policy insights from this project, as well as recommendations and future research needs.

Since the internationalisation of ICT activities is a multi-fold process and a single chapter cannot cover all of its aspects, we will concern ourselves with trade, foreign direct investment and the internationalisation of research and development. The effects of trade in ICT goods, however, are comparable in many respects with those of direct investment. Trade is also discussed in-depth by a recent EC document (European Commission 2005b).

Another important aspect of internationalisation which has not been addressed in depth in this book is the mobility of skilled personnel. Recent challenges Europe has to face with respect to ICT personnel and policies toward foreign talent, including immigration, and retention or repatriation of domestic researchers working abroad are discussed in Dumont and Lemaître (2004) and in Mahroum (2005) in detail.

2 Effects of Internationalisation

As a foundation for the subsequent discussion of the policy aspects of internationalisation, it is useful to highlight economic benefits home and host countries can derive from internationalisation. There is a considerable amount of literature on this topic (see Lipsey 2002, Barba Navaretti 2004 for recent surveys). The very basic line of argumentation is the well-known idea of comparative advantage in foreign trade (discussed in chapter II): countries benefit from internationalisation, either through exports, FDI, or outsourcing, via an increased international division of labour according to different factor endowments in the countries. This boosts productivity by enabling a more efficient allocation of resources, allowing specialisation and the exploitation of economies of scale.

Starting from this basic argument we can further distinguish between various effects of internationalisation on *home* and the *host* countries. Effects may first arise at product markets, affecting the number and composition of firms, prices, range of goods or the organisation of production within an industry. We may also find effects on factor markets, such as a higher demand for skilled personnel or other production factors and resulting effects on wages. Finally, effects could also originate from spillovers between foreign and domestic firms in a country as well as between firms at the home country and foreign affiliates. Both channels may have an impact on productivity of the domestic firms.

Analogously, the internationalisation of ICT may at first have a direct effect at the ICT sector of a country, by affecting prices and competition. Second, a higher degree of internationalisation in a country may influence ICT use and competences indirectly, for example, by altering the incentives for enterprises to take up ICT and therefore indirectly influence productivity.

2.1 Effects of ICT Internationalisation on the Target Country

We will first look at the effects of internationalisation from the perspective of the country that hosts foreign ICT enterprises, receives outsourcing or imports of foreign ICT goods. Incoming FDI and imports unfold in many ways similar effects on the receiving country; we will therefore make a distinction between the two modes only if necessary. Although only a limited number of studies exclusively deal with host country effects in the ICT sector (an example is Larrain *et al.* 2000), there is no reason that the general findings on these effects should not be applicable to ICT.

Effects from imports of ICT goods or inward FDI in the ICT sector may first arise via international technology diffusion (see Keller 2004 for a review). ICT is a general purpose technology, which means that it finds application and can boost productivity in nearly all sectors of the economy. Countries can utilize the most advanced technologies by importing machinery that embodies these technologies. It does not matter for these effects if ICT employed is of foreign or domestic origin. However, there has to be absorptive capacity, such as complementary knowledge and skills for these goods in the local economy so they can fully develop their effects on productivity.

Another effect relates to competition, prices and quality. A new entrant or higher imports may challenge incumbent firms, expose the domestic economy to greater competitive pressures and intensify competition in ICT markets - leading to higher quality and lower prices. An example was the opening of the telecommunications sector during the 1990s in various European states, which increased service quality and availability and decreased prices. Obviously, this can also have negative consequences for growth and employment if domestic firms have to leave the market.

Other effects of internationalisation are solely related to foreign direct investment. If foreign-owned firms enter a country, demand labour and domestic intermediary products and services in their host economy increases. FDI, therefore, creates jobs and growth in their own sectors and in supplier industries. There is ample evidence that foreign direct investment contributes to economic growth (for example Borensztein *et al.* 1998). The most prominent example for such effects with respect to ICT is Ireland (Barry 2004; Barry and van Egeraat 2005), where

ICT industries account for at least a third of total employment generated by foreign companies (Barry 2004, p. 203). R&D is another area where the presence of foreign-owned firms directly unfolds a significant influence on a country's overall performance. We may assume that this effect is even more striking in ICT industries, which are among the most research intensive sectors.

Moreover, there is also a consensus in the literature that knowledge diffuses to domestic enterprises not only embodied in goods and services, but also disembodied, for example, in the form of knowledge spillovers. Such spillovers are assumed to be a major benefit for economies hosting FDI and have found broad recognition in the international business literature (see Blomström and Kokko 1998). According to Magnus Blomström and Ari Kokko (2003), these spillovers are the strongest argument why countries should try to attract inward investment. Spillovers can diffuse through formal co-operation, but also (and more frequently) through supplier-user-relationships, observation of competitors etc. Another important channel for knowledge transfer between foreign firms and the domestic economy is the labour market. The transmission of these spillovers, however, very much depends on country- and industry-specific conditions, as demonstrated by Giarattana et al (2004) for the software industry in India, Israel and Ireland.

2.2 Effects of ICT Internationalisation on the Home Country

Exports or other foreign economic activities (including R&D) of enterprises have also consequences for their countries of origin. The basic argument is the same like in the case of the effects on the receiving country. In other words, benefits arise from an intensified division of labour within the company following differences in factor endowments and prices.

The benefits of exports on the activities in the home country are quite obvious. Exporting enterprises utilize their technologies at foreign markets and create jobs and growth at home. Moreover, they can achieve scale economies because they are not bound to the limits of their home market - which creates higher incentives for investment.

Exports are also related to innovation and have a two-way relationship (Bleaney and Wakelin 2002, Lachenmaier and Wößmann 2004): innovative enterprises tend to exhibit a higher export intensity than non-innovators, and exporting precedes a superior innovative performance. This can be explained, on the one hand, by the wish of the enterprises to exploit their innovations not only at home, but also at international markets and increase the returns from their innovative activities. Exporting enterprises, on the other hand, are exposed to a higher degree to competitive pressure than enterprises that restrict their operations to the home market and therefore are forced to be innovative to maintain their competitive position. Experiences in foreign markets may also turn out to be a valuable source for the development of new products.

A much more controversial issue than exports are the effects of FDI on the home country, in particular on the home country employment and labour markets (Crinò 2007). Theory predicts that the changing division of labour within the firm will lead to a concentration of capital- and skill-intensive activities at home, while labour-intensive stages of production are located in low-wage countries. Here, we have to distinguish between horizontal, market-exploring FDI that duplicates activities carried out in the home country, and vertical FDI, which substitutes home country activities and leads to a fragmentation of the production chain (Lipsey 2002, Markusen and Maskus 2001). There may be a loss of economic activity in the home country when enterprises engage in vertical FDI and relocate production to other countries. However, in the long run, overall productivity and output of the firm will increase, and this will also raise the demand for the output of the stages of production located in the home country.

The aforementioned theoretical findings are supported by empirical evidence. The majority of the studies finds no or a complementary relationship between home country employment and international activities (Brainard and Riker 1997; Braconier and Ekholm 2000; Bruno and Falzoni 2003, Crinò 2007). These results indicate that induced demand from overall growth of the enterprise outweighs the losses at the home country due to outward FDI. In this case, foreign activities require more supervising, co-ordinating and auxiliary personnel in the parent company at home. As a result of this, demand for higher skill levels at the home country is increasing.

A similar result could be observed in case study of AT&S in this project. The company has built up plants for mass-production of their main product in Asia, while European plants have concentrated on customized products for specific purposes. Increases in overall productivity allow this specialisation and upgrading of home-country activities.

Here, it is necessary to stress that economic theory and empirical studies deal with average effects of offshoring. The aforementioned theory and studies do not state that everybody is better off with offshoring and an intensified international division of labour. There are of course, winners and losers in the process; what can be said, however, is that economies in total are better off if they exchange goods rather than produce self-sufficiently.

Another important issue in relation to home country effects and FDI is the local embeddedness of economic activity. Various theoretical approaches highlight the importance of close contact to customers and suppliers for the production of goods and services - especially in creative or innovative activities. This idea has found, for example, broad recognition in the innovation literature (Edquist, 2005). Local embeddedness poses some limits to offshoring, for example when products like software have to be tailored to local demand. Local content and knowledge about consumers and markets is important in all ICT goods. It may, however, especially limit outsourcing in IT services - even though these products seem to be increasingly tradeable and transferable.

2.3 Differentiation of Effects by ICT Segments

The effects of internationalisation do not appear homogeneously across all ICT sectors, but show up stronger and more frequent in some segments of ICT than in others. We will now take a closer look at the extent to which the four main segments of ICT, as presented in Chapter II are exposed to the effects, and in which segments benefits from internationalisation for Europe seem to be the greatest. These considerations follow the basic arguments with respect to the fragmentation and differentiation of ICT sectors along their life-cycle - depending on their degree of knowledge-intensity and scale-intensity:

- *Commodified services or traditional niche sectors* often require an interaction with the client in the provision of the service. They also rely more strongly on local content or knowledge than sectors where scale effects are important. Such locally-bound services may be less exposed to foreign competition than the other types. There are exceptions to this rule, however. Call centres or other supporting activities can be outsourced to other countries. We can therefore conclude that several of the activities in this sector are likely to be less affected by internationalisation and an intensified international competition. In turn, the possibilities for an international expansion of this type of service are limited and only feasible via FDI. They are subject to the same kinds of restrictions that ensure their local embeddedness in Europe.
- Complementary arguments apply for *innovative niche sectors*, which are also characterised by a high degree of local embeddedness. In these sectors, local embeddedness may be even higher because they build on close interactions with localised scientific knowledge at universities and research centres. Empirical evidence studied in Chapter III has shown that European companies already use the advantages of fragmentation in this field - by outsourcing the production of scale intensive parts and by concentrating on the knowledge intensive parts at home. In other words, these sectors are characterised by quality competition in knowledge-intensive specialty production and/or services. They also exhibit the smallest inward and outward FDI stocks of all four sectors.
- *Traditional scale-intensive sectors*, in contrast, may face the biggest challenges from internationalisation. These sectors are confronted with fierce price competition from Asia, but also within the EU. We can observe relocation processes towards the EU10 member states in these industries. In a European perspective this relocation is clearly much less problematic that relocations to Asia. The process seems inevitable, and it should not be prevented by political measures - in order not to endanger the associated benefits from internationalisation in other sectors. The only option in these sectors consists of further improving labour productivity and focusing on sectors that are characterised by a combination of scale- and knowledge-intensity.
- This brings us to the fourth type of sector, namely *innovative sectors that are both knowledge- and scale-intensive*. This is a field where Europe has a lot to benefit from the internationalisation of ICT - if it manages to exploit leading-edge science and technology with rapid moves towards economic exploitation of new products and services. So far, however, there are only a few success stories in this sector (like SAP, telecommunications), but it is the area where the "job machines of the future" are to be expected. It is also the segment where competition is fiercest with the US, and to a lesser extent only with Asian economies. The crucial challenge consists of developing a business environ-

ment that is conducive to a swift exploitation of advances in ICT - in order to offer similar or superior conditions for domestic and foreign investors. Policy can support this process by strengthening the supply of a highly skilled workforce through its education and training policies and by supporting the establishment of innovation-friendly framework conditions and markets.

3 Implications for Policy

3.1 Key Findings on the Internationalisation of ICT

ICT is Different From Other Technologies

This project has explicitly dealt with the Internationalisation of European ICT industries because we think that ICT is different in many respects from other technologies. Technological change is proceeding very fast in ICT, which opens up new technological opportunities at a higher frequency than in other areas. More than in other technologies, innovation and production in ICT exploit its possibilities by operating in networks, thus enabling an extensive division of labour along the production chain. ICT-related applications may often be characterised by their intangible character and reproducibility. In contrast to other physical goods (either ICT goods or other industrial products), digital goods and services can be easily transferred electronically.

ICT is a general purpose technology- which allows potential application in nearly all sectors of the economy. Moreover, the application of ICT is not restricted to new goods and services. ICT also changes the way firms are organized and goods are produced, allowing a more volatile, networked, or “virtual” way of doing business. This is also an important precondition for an intensified international division of labour. It should be the goal of EU policy to make use of this intensified division of labour. This, however, implies to focus on knowledge-intensive and/or customized activities in Europe.

Internationalisation as a Key Feature of ICT

The specific characteristics of ICT have a number of implications with respect to internationalisation. A considerable number of different innovation and production activities in ICT can be highly fragmented and can be located where the best conditions for conducting them are offered. On the one hand, this entails the risk that production activities are easily re-located if better conditions are offered elsewhere. On the other hand, intensified division of labour allows concentrating on those segments of the production chain where a country or a region offers particularly good conditions. For Europe, this implies that knowledge-intensive activities (i.e. quadrants I and II) have the potential to remain in Europe and European firms may even foster their competitive position in these areas - even if large-scale production in later phases of a product life-cycle moves elsewhere. Large-scale production and less knowledge-intensive activities (quadrants III and IV), in contrast, may be shifted to locations with cost advantages to the benefit of both sides. This could also be, of course, in the EU10 member states. A prerequisite for this intensified division of labour, however, is that Europe pushes further its knowledge intensity to maintain the potential for innovation.

Firms' Motivations to Internationalize R&D, Innovation and Production

The opportunities of ICT for a more flexible, geographically dispersed organisational structure meet with the strategies of many firms to enlarge their business to locations abroad. Firms are attracted by various motives, which may be of a market exploiting nature, but also reflect cost differences. Cost advantages are the most important driver of offshoring, but are rarely the only determinant. Another important motive for firms to go abroad with their activities is the aspiration to expand sales and open new markets. This motive is often driven by the wish to exploit firm-specific assets like technology, business ideas, management skills etc. at foreign markets. Firms may also follow their domestic customers, or use the advantages of international production by internal and external outsourcing. R&D has been the activity where firms maintained a strong home base. This observation applies most strongly to Japanese firms, whereas both European firms and even more so US firms are increasingly tapping into foreign knowledge by forming alliances or making R&D investments abroad. Patent analysis has shown that this is done predominantly in the US.

Unjustified Fears and Major Benefits of Internationalisation

The advance of Asian economies such as China, India or the South-East Asian "Tiger" states, as well as the growing gap between Europe and the US in terms of ICT diffusion has raised fears that Europe's losses from the internationalisation will (out weigh potential benefits of the process). Based on the analysis of the project, we can say that these fears cannot be confirmed on theoretical grounds as well as the empirical evidence presented in the WPs.

EU Has Stabilised its Position in ICT, and Improved in Some Areas

At first, direct effects from production and foreign trade in ICT has to be differentiated from the indirect effects arising from the use of ICT. The analysis of trade flows showed that Europe has a structural deficit in ICT products. Higher unit values for European ICT exports than for imports, however, indicate that Europe predominantly exports finished goods and/or goods of higher quality than it imports. Moreover, we also find a surplus in foreign trade with ICT services. Both results indicate that Europe is increasingly specializing in higher-valued ICT goods. In the most advanced areas of ICT, i.e. those that are characterised by a high degree of research and knowledge-intensity (Quadrant I and II), the best locations in Europe are competing in the first instance with those in the US. This applies to both inter-firm competition and for intra-firm competition. An example that may further illustrate this is the case study on SAP where competition is fierce between the Palo Alto and Walldorf locations of the enterprise. The perception that the US offers better and more attractive conditions for innovation (for instance in terms of regulations, but also access to excellence in research) is perceived as a threat in the medium term for retaining the cutting edge activities of leading companies in Europe.

A pure price competition in trade in ICT goods is not an option for EU 25; focus should be on quality competition. Evidence indicates that such a process is underway. Moreover, the EU 10 member states have gained momentum in ICT foreign trade in recent years. The analysis of FDI flows in ICT also supports the finding that an intensified division of labour between Europe and other parts of the world is currently emerging. Active as well as passive foreign direct investments have increased in all ICT sectors and countries where data is available with ICT hardware producers and business services being the strongest internationalized sectors. European firms also maintain strategic R&D activities mainly in the home country, despite cost advantages in other parts of the world. These activities are strongly rooted in the innovation systems of the firms' home countries. However, there is a growing tendency to set up R&D facilities abroad, mainly to support local production and market expansion.

A second argument why fears may be unjustified refers to the indirect effects of ICT on productivity and transaction costs. These indirect effects arise from the use of ICT in different sectors of the economy, regardless if imported goods or goods originating from the EU have been employed. In contrast, one may argue that foreign ICT goods may even have a better cost/performance ratio or embody superior knowledge which may lead to spill-over effects to European industries. A prerequisite for these effects from the diffusion of ICT, however, are complementary skills that enable enterprises to make use of ICT and employ them in an innovative way.

Europe Needs to Continue Moving Up Towards Higher Knowledge-Intensity, Quality, and the Development of Skills

Opportunities for Europe reside mainly in higher demand for advanced services and goods, R&D intensive activities, and quality competition rather than price competition. This requires a stronger orientation towards innovation and R&D. Two major reasons indicate that major attention should be laid on skills and HR development: First, because a further specialisation of the EU member states on high-valued goods can only be a promising strategy if it is accompanied by constant skill improvements. This is also true for the EU 10 countries, which – for the moment – still benefit from lower labour costs which allow them to provide labour cost advantages similar to Asian locations in production. However, in the medium-term, the picture is likely to change.

A second argument in favour of skills development is absorptive capacity. Major effects of ICT do not only arise in industries that produce ICT, but also downstream in user industries. To employ these technologies, however, firms need a certain level of technological expertise, also referred to as absorptive capacity. Therefore, it is important to invest in ICT-related education and R&D. Skills development should also be accompanied by employees' flexibility and ability to learn throughout their entire working life.

Internationalisation of ICT Facilitates the Internationalisation of Other Sectors

ICT is not only subject to internationalisation and fragmentation, it is also a major enabler of the process because it allows easy exchange of information between various locations, and therefore helps to co-ordinate a geographically dispersed production structure. Due to this enabling character, the widespread use of ICT in other sectors is likely to facilitate a move towards internationalisation and fragmentation of production too. However, for tangible and physical goods this will not reach the same level as for digital goods and services that can be easily transferred electronically. Due to the growing importance of digital goods and services, this mechanism is much more relevant in ICT than in other industries. Nonetheless, the increasing use of ICTs and digitalised information along the value chain in most industries outside the ICT sectors facilitates similar processes of relocation and fragmentation as we have observed in the ICT industries. Whether this development will turn into a real challenge for this specific European industry remains to be seen, but it should be monitored closely.

3.2 Policy Conclusions

Based on these findings, we will now discuss some key issues and options for EU and Member States policies that are likely to determine whether Europe will be able to maximise the benefits from internationalisation in ICT.

Coping With the Next Phase of Restructuring of European ICT Industries …

Over the coming years, a new wave of restructuring in Europe's ICT industries is expected. Major production facilities, for instance, in micro-electronics, will have to be replaced by a new generation of plants, and the decisions on future production locations are open. It is unclear whether locations in Europe will still be able to win these large-scale investments in ICT production facilities, and under which conditions they may be in a position to win them. In more general terms, this raises the question whether European policy should actively support the European ICT industry to move towards "Quadrants I & II", or, in other words, to move towards the provision of highly knowledge-intensive goods and services and give up on scale-intensive, but less knowledge-intensive production activities in recognition of global fragmentation.

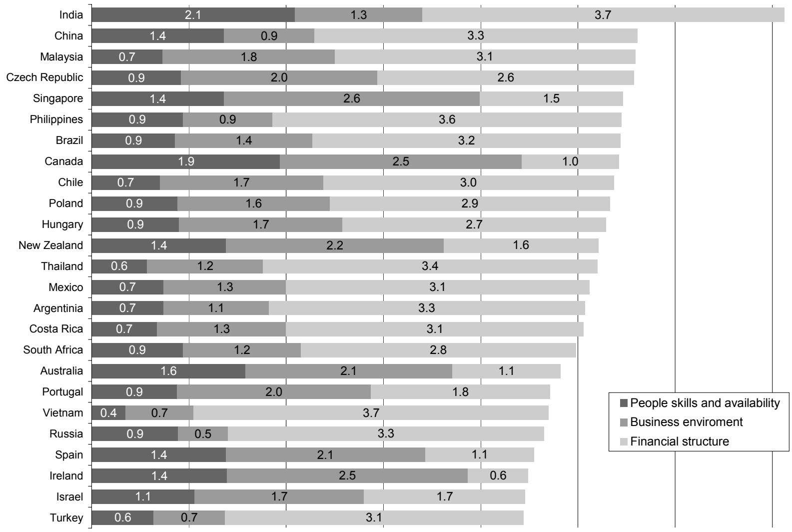
In this context, it is important to take a look at the possible division of labour between different locations in Europe along the production chain. The member states of the European Union play very different roles in the process of internationalisation. Some of them, namely the new member states of the EU 10, offer considerable cost advantages to investors. Manufacturing unit labour cost in the Czech Republic, Poland or Hungary, for example, are only a third or a fourth compared to France or the UK (Guger, 2005). The difference to Germany, Finland or Belgium is even higher. Compared to South-east Asia, however, unit labour costs are quite similar in the EU 10, while the EU 10 countries enjoy some other non-cost location advantages like a more favourable business environment when compared to Eastern Asia. The key concern with respect to the EU 10 countries must be seen in the temporary character of their labour cost advantages, assuming – and hoping – that they will catch up with the EU 15 in GDP/capita and wage levels in the foreseeable future. However, the wage gap has been closing only slowly over the past ten years, and it is likely to continue to be like that for several years to come.

In view of fragmentation along value chains in ICT, there seems to be little doubt that European firms must concentrate on highly knowledge-intensive activities, in particular on services. The global division of labour along these value chains implies that high-tech ICT manufacturing is not a pre-condition for providing corresponding knowledge-intensive services. There may also be certain niches where production facilities in Europe are economically viable - for instance, due to their high knowledge-intensity, their specialised character or the need for close collaboration with users. With respect to scale-intensive production (which are located in Quadrant IV), the exploitation of wage differentials in Europe, which are likely to persist for at least one generation of ICT production facilities, offers an opportunity to maintain also some of these production activities in Europe. For R&D policy, this implies that it should pay much stronger attention to research and innovation in services, and that it should seek a new balance with funding opportunities directed to innovation in production.

Inward and Outward Foreign Direct Investment – a Matter of General Economic Conditions Rather Than of Specific Incentives

Measures to improve the attractiveness for foreign direct investments in ICT are a key issue in ICT policy-making, and there is a controversial debate on the need (or not) for specific incentives. If successful, public subsidies for FDI promise a high return on investment. However, as a guiding principle, there is only little justification for an active policy that tries to attract foreign investment by means of financial incentives. The theoretical literature comes to the conclusion that in the absence of externalities and market failure, a division of labour not affected by distortions from public policy may ensure the highest welfare for both, host and home countries. Moreover, since there is no clear empirical proof that FDI incentives work (Oman, 2000), such measures may rather be a transfer of taxpayer's money to MNEs than an effective instrument to promote growth. A third concern against active policies is that they may lead to prisoners dilemma-like situations between governments competing against each other for investments. This kind of policy competition may lead to sub-optimal outcomes at the European level. Moreover, some determinants of country attractiveness cannot be offered to foreign enterprises alone, like political stability, skilled personnel or an increased quality of university research.

Instead of special FDI incentives, governments should rather concentrate on improving business conditions for both foreign and domestic enterprises. The literature highlights the importance of a healthy business environment, social cohesion and macroeconomic stability for attracting FDI (Blomström 2001; OECD 2003a). According to A. T. Kearney (2004), such framework conditions are one of the locational advantages associated with European countries such as: Ireland, Hungary, or the Czech Republic. In the competition with the most knowledge-intensive locations for FDI, especially the US, soft factors (e.g. flexible labour regulations, low administrative burdens, etc.) seem to play an important role next to the access to scientific excellence in institutional and human resource terms. Only countries that offer such favourable conditions are also attractive to foreign enterprises. Compared to the US, they are offered by some leading locations in Europe, for instance the Scandinavian countries, Germany, the Netherlands, France or Belgium. Measures aiming at improving these general conditions for doing business will benefit both foreign and domestic enterprises.



Source: A. T. Kearney (2004)

Fig. 65. A. T. Kearney Offshore Location Attractiveness Index 2004

Numbers are index numbers; financial structure is weighted on a scale of 1 to 4, business environment and people skills on a scale of 1 to 3.

Strengthening framework conditions is the appropriate way to attract foreign R&D for the following reasons: First, empirical evidence as well as theoretical insights suggest that overseas R&D investments follow FDI to a large extent. Second, we know that a second major attractor of R&D is scientific excellence and stable framework conditions. Measures to foster domestic R&D and innovation in Europe mentioned above will therefore also attract foreign-owned R&D units. A special policy designed only at foreign firms or other positive discrimination does not appear to be appropriate and may not be feasible due to international agreements and EU treaties.

Past experiences have also shown that foreign investment is not necessarily bound to stay. The next generation of investments may easily go elsewhere - if better conditions are offered. The key issue for making foreign investments sustainable is thus whether mechanisms can be devised to ensure that these investments can be "rooted" in the local innovation and production system. Nevertheless, this is also an important pre-condition for enabling benefits from spill-over effects to the local economy.

Excellent Conditions for Conducting Research and Knowledge-Intensive Services

The provision of excellent conditions for research and knowledge-intensive ICT-services should be a focal point of all policies regarding internationalisation of ICT. It is a key factor not only with respect to foreign investments and their rooting in the local innovation and production system, but also to support a general strategy of moving towards Quadrant I.

Attention should be paid to the supply of creative scientific and engineering talent and to the promotion of research, technology development and innovation. This is crucial in several respects: first, R&D can create new comparative advantage for European companies; second, we know that the scientific and technological capabilities and capacities of a country are an important determinant for FDI inflows. Ensuring attractive conditions in these two respects is a key responsibility of governments in the context of the internationalisation processes.

The European Commission contributes to the development of Europe's creative potential by the Framework Programmes, by its efforts to create a common European Research Area, and by the Structural Funds. Since private investment in – mainly applied – ICT R&D considerably exceeds public expenditures, government funding should be concentrated on well-defined target areas where the market or system failure arguments apply. This holds true in particular for basic research and education in ICT (i.e. two functions associated with universities and certain research organisations in most European countries), but also for R&D activities that are geared towards the creation of new knowledge-intensive services.

Government R&D funding could also be justified in R&D areas where government exerts a strong influence through its demand and procurement function, i.e. as a "leading user" and customer of ICT-products and services. Supporting the creation of markets in Europe by means of innovation-oriented public procurement is also one of the inroads that have been highlighted in a recent report of an EC expert group (Aho et al. 2006).

Excellence is more than a matter of funding and skills, it also relates to the institutional conditions in the research and innovation system. As shown by the current situation of the EU 10 countries, investment in ICTs must be "locally embedded" and "rooting" in the local economic and institutional tissue. The availability and continuous upgrading of skills and capabilities of the local labour force, as well as the promotion of excellence in research are conducive for ensuring the local embeddedness of investments in ICT. It can be further strengthened by the provision of products and services that are tailored to local demand, or when an interesting combination of factors coincide (e.g. the cluster approach). Otherwise, there is a risk of offshoring of investments after a few years - when labour costs in the EU 10 have increased compared to Asian locations. Policy should thus pursue a system-oriented approach that supports the embedding of ICT investments by a range of instruments: R&D policy, institutional framework conditions, labour market policies, human resource development, etc.

Ensuring Access to and Exploitation of Knowledge Worldwide

Strengthening the ties between firms and research organisations, on the one hand, and the best sources of knowledge worldwide is essential to increase embeddedness and avoid offshoring of highly knowledge intensive ICT activities. This is not only important for keeping domestic and foreign-owned firms in the country, but also to enable spill-over effects from foreign firms - which tend to perform better in many respects than domestic ones to the local economy. As shown by the patent analysis, the ties in ICT R&D are increasingly strengthened between the US and Europe, whereas the activities in Asia seem to be less interlinked with the main knowledge sources in the US and Europe. This indicates that the global R&D hotspots are still in Europe and the US, and that North America and Europe complement each other in some respect. European firms tend to rely strongly on their local knowledge sources, whereas US firms are better at tapping knowledge sources outside the US.

However, access alone is not enough. It is the economic exploitation of global knowledge that matters for growth and employment. In this respect, US companies still seem to have an advantage. Alliances between EU and US firms at the leading end of R&D are thus a double-edged sword: Both sides benefit from the access to the best knowledge sources in the world, but with respect to exploitation the situation is more imbalanced. For policy, this implies that linkages between European organisations and knowledge sources outside of Europe should at least not be hindered. In addition, measures should be taken to increase the absorptive capacity for new knowledge and hence the probability of spillovers from knowledge acquisition - in order to benefit from R&D alliances or from the presence of foreign firms in a country.

In Need of ICT-Specific Policies for Internationalisation?

Policies both at European and international level strongly determine the context in which the internationalisation of ICT takes place. In particular, EU competition policy, regulations concerning state aids vis-à-vis EU framework programmes and, at the international level, international trade and investment agreements need to be mentioned in this context. These policies are of a generic nature and are applied across all industrial and/or service sectors. If, however, the argument is sustained that ICT is “special” in terms of its characteristics and its economic impact, then the question must be raised whether there is a need for targeted internationalisation policy for ICT or at least a very pronounced consideration of ICT-related aspects in generic policies.

As argued before, information and communication technologies deserve special attention for two simple reasons: First, ICT producing sectors grow faster than other parts of the economy. Since ICT is an international industry, growth of ICT industries is fuelled to a large degree by external trade and FDI. Second, the diffusion and use of ICT promotes innovation and productivity increases in a wide number of user industries - with internationalisation in these industries being facilitated by the use of ICT.

Due to its importance for downstream user industries, some countries regard ICT as a strategic sector, and thus tend to be sceptical about internationalisation and fragmentation in ICT. The assignment of this “strategic character” of ICT depends on the assessment of a variety of issues. There are concerns that it is necessary for a country to host ICT-producing industries - in order to be able to reap the benefits from ICT. Proponents of this view are obviously critical of the observed process of fragmentation of value chains, which tends to hamper the building up of “national absorptive capacity”. This view, however, is contrasted by a perspective where countries benefit most from internationalisation due to intensified competition and due to faster diffusion and usage of ICT. To enable this, a higher degree of flexibility in terms of firm organisation, as well as economic structure, is needed. Therefore, policies to maximise the benefits of internationalisation of ICT should promote flexibility and change - rather than protect strategic positions.

In the preceding parts of this chapter, we saw that there are considerable benefits to gain for countries from internationalisation. Beside direct employment and growth effects, we may assume that an intensified competition, technology diffusion and spillovers of knowledge in addition trigger economic growth in the host countries. Home countries of multinational enterprises may also benefit from the effects of an intensified international division of labour, which may increase overall productivity at home and abroad.

There are some issues that seem to be special in the case of ICT- in terms of its patterns and mechanisms of internationalisation. For instance, some types of ICT goods and services (especially digital goods and services) can be reproduced and transferred internationally at (almost) zero cost, implying that special attention needs to be paid to IPR issues.

In conclusion, we may argue that it makes accurate sense to give the special characteristics of ICT more weight in the definition of international and European policies affecting internationalisation of industry in general. These policies, however, should not go as far as interpreting ICT as a field that it merits distinct measures to protect national interests.

Fostering the Responsiveness of Institutions and Innovation Systems to the Dynamics of ICT

The analysis of this book has shown that ICT is a highly dynamic area of techno-economic development, characterised by a fast pace of change and highly mobile enterprises and investors. If Europe wants to keep pace and influence these dynamics, it will have to ensure that its institutions and key organisations in the area of ICT are sufficiently flexible to adjust to fast-changing circumstances. It implies that they need to frame the development towards Quadrant I and II type of activities and be more open to ICT-based knowledge-intensive service activities.

This point applies to R&D and innovation-related, but also to other institutions. An example of this is the financial framework. Since ICT sectors are often characterized by a high share of intangible assets, there is a particular problem for continental EU countries with dominance of bank lending - which relies on availability of adequate traditional collateral. Both financing ICT start-ups and internationalisation strategies of ICT firms will face serious problems unless the role of capital market is reinforced by new national legislation - a general challenge for a knowledge-based society.

Moreover, well-functioning labour markets are essential for adjustments of the industrial structure. Even the most optimistic scenarios in terms of exploiting the opportunities offered by internationalisation will have significant implications on the labour force. Rising levels of offshoring, for example, also call for an active labour market policy that helps to bring people who lost their job due to offshoring back into the labour market. The benefits from an increasing division of labour can only be gained when structural change can happen fast, and workers smoothly move from one sector to the other (stressing, once again, the training and re-training issue). The OECD employment outlook (OECD, 2005) finds that re-employment rates are considerably lower in Europe than in the US, which indicates that the unemployed in Europe find it more difficult to get back into work following trade-related replacement than in the US. Making labour markets flexible is one factor required to facilitate adjustment processes to take place.

Policy, however, will also have to provide some safety-nets. Gains from internationalisation should be used for a redistribution of factor incomes to compensate for losses from the process. Although the majority of studies on average finds no or a complementary relationship between home country employment and international activities, it is almost certain that there will be losers of the restructuring process. Raising skills levels and retraining will undoubtedly turn into a major issue in the course of this process and policy will have to support this process by enhancing flexibility in labour markets and implementing education and training schemes.

Not all ICT jobs in Europe will be highly knowledge-intensive in the future, and there also need to be opportunities for the less skilled. Many skill-extensive and scale-extensive activities tend to be of a localised service type, i.e. they are bound to stay close to the final users and markets. However, Europe should be aware that these areas are not likely to turn into major “job-machines” any more. The remaining jobs in these segments will nevertheless be essential for offering an employment perspective to those who will not be able to follow the upskilling process towards high levels of knowledge-intensity.

A Neo-Mercantilist Position is not Appropriate

In conclusion, Europe and the European governments should be aware that the internationalisation of ICT is an opportunity for Europe. A position that tries to attract incoming FDI while retaining outflows, or promotes exports of ICT while trying to restrict imports, does not seem appropriate for three reasons: First, countries that follow a protectionist policy have very weak arguments when other countries impose such measures on them. Second, it would hamper the international diffusion of ICT to Europe and may slow down productivity gains from the usage of such technologies. Third, such a policy may lead to distortions in factor allocation and rather reduce than enhance overall welfare gains from the internationalisation.

4 Final Remarks

This first comprehensive report about the internationalisation of Information and Communication Technology (ICT) has developed new analytical concepts, combined theoretical analysis and empirical research and generated a rich body of case study-based evidence of the ICT sector. Given the continuous expansion of ICT in OECD countries, there are several long-term topics which will be new issues on the agenda of both researchers and policy makers - and thus deserve a strong focus in the future:

- Development of patent shares of ICT sector across countries and relative positioning in the world economy.
- Employment dynamics in terms of relative demand for skilled and unskilled workers plus ICT-based opportunities for skill-upgrading - including digital lifelong learning.
- Structural ICT developments in terms of reduced relevance of hardware and rising importance of software and other intangible assets.
- ICT-related imperfections of digital information and knowledge markets - which could undermine the endogenous growth potential of a networked knowledge society
- Issues of digital property rights and patenting in a digital world economy.
- Opportunities for a new digital development policy of the EU which supports growth, trade, investment and networking in the global economy.
- Perspectives for progress in the digital society which should include avoiding digital divide within society and across EU countries.

The EU as a regional integration project, which has achieved considerable progress in terms of deepening and enlargement, faces enormous challenges and opportunities in the context of ICT expansion. While many problems can be solved within the EU, there are also topics and issues - which require collaboration with other integration areas (e.g. ASEAN, NAFTA, MERCOSUR). Given the fact that ICT expansion concerns a long term development - often also shaped by complementary cyclical digital business impulses - it is quite crucial to monitor and analyze the ICT dynamics in Europe and worldwide. There are not only broad challenges from an economic and technological perspective, it is also clear that the digitally networked EU society of the 21st century will be a unique historical development. Equality of opportunity, economic welfare, social cohesion and progress all have a digital perspective - which needs to be explored continuously.

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Appendix A.I Aspects of Internationalisation of Digital Goods Producers

1 Accompanying MNEs: A Theoretical Approach with IT Services Providers

Regarding the possible cross-border relationships of IT service companies, the mandate to accompany a (domestic) customer is the focus of this section. Miozzo/Miles (2002) and OECD (2004c) emphasize that for many (IT) service industries, the initial stimulus of their internationalisation was the rapid growth and global spread of multinationals in manufacturing sectors. Offering B2B services, the IT service companies follow the internationalisation pace of their customers. In this section, this case is examined theoretically, and the link between the organizational structures of companies, IT administrative rights and the basic choice between two IT system architectures is described. It is proven that the choice of the IT architectures coincides with the choice of the organizational structure of the company, which leads to the result that trading strategies come along with an interface solution whereas vertical integration may favour proprietary solutions. In the following section a general equilibrium model is taken into account which considers the choice of a company's structure as endogenous, leading to implications for the internationalisation of IT services. The endowment of a country with labour and capital determines the decisions of final goods and intermediates producers to integrate or to remain independent, with the consequence that IT Services companies with customers in capital intensive industries are pushed to globalize their business as well.

The model presented in this section is based on the property rights approach by Grossman/Hart (1986) and is similar to the concept put forward by Brynjolfsson (1994). The model supports the results reached by Williamson (1985) that transaction costs of any economic activity are determined by the asset specificity associated with that activity (Ang/Straub (2002)).

Grossman and Hart analyze the distribution of property rights between two companies with incomplete contracts. They also prove that a uniform distribution of the property rights (i.e., both companies remaining independent) can lead to economically efficient results. With this model they offer an alternative explanation to the transaction costs approach à la Coase and Williamson.

Analogously to property rights, IT administrative rights are considered here. These determine the access policy on the IT systems S_F and S_J from final good producer F and intermediate good producer J. The administrative rights include, for instance:

- the control of access including all internal and external safety measures and administration of users, that is the assignment of users to roles which encompass certain access rights.

- all system changes or expansions and changes in the data model and
- the possibility to access all relevant company data stored electronically such as customer lists, prices, etc.

IT systems are a mirror-image of the enterprise production processes. Therefore controlling the IT administrative rights also allows for the observation and control of the company's workflow. Thus IT amdinistrative rights are an essential subset of property rights. The following model shows that the choice of the IT system and the distribution of the property and IT administrative rights take place simultaneously.

It is the common objective of intermediate good producer J and final good producer F to increase the total productivity of what can be reached by a better coordination of the operational processes between both companies. This concerns, for example, order processing, production, logistics, etc. This coordination is carried out by information technology, specifically by exchanging data between companies. In the model, two possible IT architectures can be chosen to organize the data interchange between the companies:

1. Standardized interfaces. This means that the “point of transfer” is standardized and documented openly as well as the exchange format itself being in common use. An example is the data interchange via an ODBC (Open DataBase Connectivity) interface.
2. Integration of the systems establishing a proprietary system with individual solutions for the data interchange.

The administrative rights which are at the disposal of the companies in both these cases are termed A^F or A^J. The following cases are conceivable:

- $A^F = \{S_F, S_J\}, A^J = 0$ Integration solution 1: The final good producer has the administrative rights for both systems or for the integrated system, respectively.
- $A^J = \{S_F, S_J\}, A^F = 0$ Integration solution 2: The intermediate good producer has the administrative rights for both systems or the integrated system, respectively.
- $A^F = \{S_F\}, A^J = \{S_J\}$ Interface solution: Every company keeps the IT administrative rights for its system. Data are interchanged through interfaces.

Intermediate goods producer J and final goods producers F have to invest for their IT systems amounts of K_F and K_J, respectively. The cost function for producing the intermediate product is termed C and depends on the investment volume of the intermediate goods producer in its IT system with

(3) $C = C(K_J)$ with $C' < 0$ and $C'' > 0$

After having purchased the intermediate goods from the intermediate goods producer J the final goods producer F sells it to its customers. Expenses for finishing, marketing and logistic are deducted. This generates a turnover R which depends on the investment volume of the final goods producer F in its IT system:

(4) $R = R(K_F)$ with $R' > 0$ and $R'' < 0$

If both producers could agree on a complete contract, both companies would distribute the IT administrative rights ex ante and would also bindingly negotiate the investment volumes K_F and K_J and the split of profits. They would then maximize the profit function $R(K_F) - C(K_J) - K_F - K_J$ together.

However, de facto this is not possible. Grossman/Hart (1986) point out that in a contract between two companies, all eventualities can never be regulated. In this sense the contracts are incomplete. The company which will prevail in the case of a conflict disposes of the residual rights (i.e., about the rights which could not be described by the negotiated contract completely).

Residual rights also exist in the area of administrative rights. If, for instance, an interface solution is agreed on between two companies, the actual investment volumes of a company in its entire IT system remain unobservable although this is crucial for the quality, consistency, safety and availability of data.

Therefore it is assumed that both companies negotiate only an incomplete contract which only determines the distribution of the IT administrative rights ex ante, but neither the investment volume in the IT systems nor the split of profits can be negotiated bindingly.

The business transactions between the companies may follow this time line:

- period 0: The type of the IT system architectures and the distribution of the IT administrative rights are determined.
- period 1: Both companies choose their investment volumes K_F and K_J .simultaneously and independently of each other
- period 2: The companies mutually observe the actual size of their IT investment volumes and decide whether they want to trade intermediate goods between each other. At the end of the period the companies negotiate on splitting the profit.

Splitting the profit follows a Nash-bargaining solution. For the negotiating position of the parties the value of their outside options V are crucial. These describe the alternative revenues which can be expected when the intended deal does not work out

By assumption hold $R(K_F) - C(K_J) > V^F(K_F, A^F) + V^J(K_J, A^J)$ with $V^F(K_F, A^F)$ for the outside option of the intermediate good producer, whose value depends on the actual investment volume in the IT system and the received administrative rights $V^J(K_J, A^J)$ accordingly. The assumption causes the intermediate to be traded between both companies. For a stable solution, it is assumed that by increasing the investment volume by one unit the marginal revenues rise more strongly and the marginal costs fall more strongly than the value of the outside options increases: $R'(K_F) > V_1^F(K_F, A^F)$ and $C'(K_J) > V_1^J(K_J, A^J)$ with V_1 for the first derivative of V with respect to the first operand K.

The value of the outside option depends on the distribution of the administrative rights and IT architecture chosen between both companies for data interchanging (e.g., the interface solution or integration of the systems). It holds

- with an integrated system:

(5) $V_1^n\{K_n, A(S_F, S_J)\} > V_1^F\{K_F, A(S_F)\} = V_1^J\{K_J, A(S_J)\} = 0$

with n = (F, S). As soon as an integrated system is built up, the individual investments of the companies are also sunk in the entire system. Hence, if a company owns only the administrative rights for its "subsystem," the value of its outside option is zero.

- with standardized interfaces:

(6) $V_1^n\{K_n, A(S_F, S_J)\} = V_1^F\{K_F, A(S_F)\} = V_1^J\{K_J, A(S_J)\} > 0$

with n = (F, S). With the interface solution, a separation of the partners is possible anytime without impairing the integrity of the systems (i.e., the IT systems remain functioning). The investments in the IT system do not become sunk costs. Hence, presuming a symmetrical investment behaviour, the single value of the outside options of each company administrating its own IT system meets the value of the outside option of one company having received the administrative rights for both IT systems.

The Nash-bargaining solution determines the actual profit from the trading relationship between both companies. For the final goods producer

(7) $U_F = \frac{1}{2}\{R(K_F) - C(K_J) - V^F(K_F, A^F) - V^J(K_J, A^J)\} + V^F(K_F, A^F)$

and for the intermediate goods producer:

(8) $U_J = \frac{1}{2}\{R(K_F) - C(K_J) - V^F(K_F, A^F) - V^J(K_J, A^J)\} + V^J(K_F, A^F)$

Assuming that the IT investment costs are completely written off in the considered period, both companies choose their optimum investment volumes K_F^* and K_J^* in such a way that the profit function is maximized after amortizations $(U_F - K_F)$ and $(U_J - K_J)$, respectively. For the final goods producer, the following is the case:

(9) $K_F^* : \frac{1}{2}\{R'(K*_F) + V_1^F(K*_F, A^F)\} = 1$

and for the intermediate goods producer

(10) $K_J^* : \frac{1}{2}\{-C'(K*_J) + V_1^J(K*_J, A^J)\} = 1$

Interpretation

Incomplete contracts and the split of profits à la Nash lead to distortions compared to the solution with complete contracts. With complete and binding contracts, the joint optimization calculation of $R'(K_F) = 1$ would have yielded $-C'(K_J) = 1$. However, a hold-up problem arises with the Nash-bargaining solution, namely that the optimum investment volume of the intermediate goods producer decreases, because only 50% of the marginal costs are now relevant for its profit maximization. For the final goods producer, the same holds. Hence, underinvestment occurs, except for the borderline case for which the value of the outside option meets the value of the originally carried out investment exactly.

Following the argumentation of incomplete contracts, both companies try to keep the magnitude of the distortions as low as possible from the beginning. The negotiating positions, the value of the outside options at the end of period 2, are anticipated, and the administrative rights are already distributed accordingly in period 0.

In other words, the theory of incomplete contracts also leads to a solution which is economically efficient with respect to the constellations possible.[1] The interdependent relationship between administrative rights, property rights and the IT architecture chosen becomes apparent, leading to the following results:

1. Establishing an integrated IT system for which only one of the partners receives all administrative rights. The proof is that if both companies disposed of partial administrative rights, the propensity on the part of one company to invest could be increased by redistributing the administrative rights, without affecting the other.[2]
2. This also applies when the actual operation of the integrated IT system (programming, installation, administration, servicing) is carried out by an external company. Accordingly, Quelin/Duhamel (2003) argue that outsourcing should be a distinctive feature of specific firms in an industry to gain and keep a competitive advantage.

With a system based on standardized interfaces, both companies should hold administrative rights for their sub-system. If a company received all administrative rights, transferring these rights to the other company would increase its propensity to invest without decreasing the investment readiness of the dispensing company.

Deviations from this solution lead to disadvantageous economic side effects. If, for instance, the final good producer compelled a supplier to use non-standardized, but proprietary interfaces, it improves its short-term negotiating power. On the other hand, this strategy causes the intermediate goods producer to lower its investment volume, thereby negatively affecting the operational profit of the final good producer. The final goods producer must resolve a trade-off between improving the negotiating position or promoting cost-efficient production of the intermediate good. The distribution of administrative rights and the choice of the IT system architecture coincide. From this, two different points-of-view can be observed:

- Management literature's view: When changing the organizational structure of a (multinational) company, existing IT systems must be taken into consideration. For instance, a merger between two companies can fail (i.e., the additional

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[1] Theoretically only this "anticipated ex-post-2nd-best-solution" allows for the incorporation of incomplete contracts in general equilibrium models.

[2] This does not contradict the modus operandi that in reality a system administrator assigns limited rights for parts of the system to others.

costs exceed the additional returns generated) if the IT systems cannot be integrated due to technical reasons.

- Macroeconomic point of view: The type of Information and Communication Technology spreading more rapidly also depends on the cooperation between companies and thus on basic economic factors. A standardized interface solution is likely to occur with trading strategies, but a proprietary IT solution is more plausible the more closely companies integrate. On a spot market, the relationship between the trading partners is short-term and often anonymous. Homogenous goods are traded. Following the approach of the IT administrative rights, the companies keep their rights completely, because the costs of changing the trading partner have to be small. Therefore trading on spot markets rely on standardized interfaces (with or without data intermediaries), and the values of the outside options are positive for both trading partners. When the companies integrate or exclusively cooperate along the value chain, however, it is crucial due to the property rights view to protect the knowledge needed specifically for the products. "Exit costs" are higher the more integrated the IT systems are. Hence, individual IT solutions (i.e., individual ERP- and CRM-systems[3]) should be favoured by vertically integrated companies.

Criticism of the Approach

This approach to relate organizational issues with information technology is simplified by the choice between only two architectures. In reality no solution can be observed in pure form, but this theoretical approach nevertheless gives important hints to economic trends in the real world. Despite this, one can still criticize the approach from a model-theoretical view:

- Companies have more than one trading partner. Hence, several ways of interaction and data interchange exist in reality.
- The results may change when considering more than one period.
- The input factor "trust" is not taken into account. Confidence between trading partners is a crucial precondition in order to raise total productivity. This may especially be true if considering more than one period. Leamer/Storper (2001) point out that trust comes from relationships, particularly in the internet age.
- Investments in IT have a double function in the presented model. They reduce the marginal cost or increase the marginal revenues respectively; at the same time they are necessary to build up the interfaces or to integrate the systems.
- The organizational consequences of choosing an IT architecture are not addressed. Kling/Lamb (2000) point out the importance of sociotechnical support when an IT system is implemented. They describe one case in which "divisions fought cooperation with the new system, attacking its design, technical adequacy, and feasibility. This process dragged on for years, costing numerous hours of effort and meetings. Divisional accountants even attempted to sabotage the system..."

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[3] EPR: enterprise resource planning; CRM: customer relationship management

However, this criticism does not change the main result which is important for the further argumentation, namely that the choice of the organizational structure and of the IT systems architecture coincides.

International Equilibrium

In this section a general equilibrium model is described which allows linking the factor endowments to IT systems architecture.

According to the theory by Coase (1937), the distribution of property rights is irrelevant as long as they are distributed consistently. Hence, this topic was left unattended in economic literature for quite some time in contrast to management literature. More recent research points to the interdependence between organizational structures and trading patterns and considers the choice of the organizational structure of a company as endogenous in general equilibrium (GE) models. In these models incomplete contracts or incentive systems for managers are integrated to overcome the conclusions of Coase that the distribution of property rights is insignificant from a macroeconomic point of view. Examples for GE models are the model from Antras et al. (2005), in which communication costs determine the quantity and quality of international outsourcing. A similar approach, put forward by Antras (2003), is described in this chapter in more detail. Other authors model search costs more explicitly (e.g., Grossman/Helpman (2005), Rauch/Trindade (2003), Grossman/Helpman (2002b)). A comprehensive overview about the GE models with endogenous determination of the organizational structure is given by Spencer (2005).

Antras (2003) analyzes the link between organizational structures of a company and capital and labour resources. He first focuses on a closed economy, then extending the model under inclusion of the factor price equalization region from Helpman/Krugman (1985) to several countries. The closed economy encompasses two industries with differentiated products which both need product-specific intermediates. The production of the intermediates takes place according to Cobb Douglas-production function with labour and capital. Intermediate manufacturers and final goods producers have only the possibility to conclude an incomplete contract as described by Grossman/Hart (1986).

The negotiating power in the Nash-bargaining process determines the organizational structures of a company. Both partners receive reimbursement according to the values of their outside options as well as a fixed share of the profit exceeding them. A standard assumption in GE models contends that the profit share for the final goods producer is always more than 50 percent.

The final goods producer has to solve the trade-off between its negotiating position during the Nash-Bargaining procedure and the profit losses caused by an underinvestment of the intermediate manufacturer. Antras (2003) integrates this schema of incomplete contracts into a general equilibrium model. The investment behaviour of the intermediate and final goods producers whose numbers are determined endogenously employ all supplied labour and capital in equilibrium. Summing up, outsourcing solutions are more common in sectors with labour-intensive intermediates, while integration is favoured in sectors with more capital-intensive intermediate goods.

Considering more than one country, Antras (2003) assumes that intermediates are tradable but neither the final products nor the input factors are. For two countries with "relatively similar" resource-intensities of capital and labour implying factor price equalization, the model has the result that the share of in-house imports is higher the more capital intensive an industry is.

Incorporating the results of the previous sections allows a twofold interpretation of the international structure of the IT service sector (Vogelsang (2006a)):

- Perspective a) interprets IT as a self-contained intermediate. From the presented model of Antras (2003) follows directly that outsourcing solutions are favoured by labour rich industries, whereas the integration of IT service providers may mainly occur in capital rich industries.
- Driven by the love of variety assumption on the demand site and confirmed by factor price equalization, all countries produce variants of all sectors. Due to different partial specializations in a capital intensive country, however, in house offshoring dominates international outsourcing and domestic in-house production dominates domestic outsourcing. For labour intensive countries, international outsourcing dominates international offshoring.
- Perspective b) considers IT service companies accompanying multinational enterprises. Since outsourcing of non-ICT intermediates is favoured in labour intensive industries, final and intermediate goods producers keep their own IT systems (they do not integrate), and IT has to provide standardized interfaces. In capital intensive industries, however, vertically integrated companies are preferred, and IT must support the proprietary systems.

These perspectives describe different forces which influence the market structure in the IT sector. Internationalisation of a capital intensive industry implies that (domestic) IT service companies must also internationalize, a pattern which has favoured the international expansion of SAP, for example. Yet in labour rich industries, local IT service companies may be employed; this is favoured by open and standardized interfaces and may also lead to stronger competition in the country of origin in a subsequent stage.

Finally these findings may have an impact on economic policy. For example, they are applied to the discussion about software patents:

1. Capital intensive industries show a higher inclination for the integration of foreign production plants.
2. Integrated companies prefer proprietary IT systems.
3. Labour rich countries should therefore predominantly support open standards.
4. From a theoretical point of view, however, integrated industries and trading (outsourcing) industries also coexist.

This implies that economic policy may be the rationale which supports proprietary solutions (e.g., through patents as well as open standards simultaneously). The respective arguments have been mentioned in the most recent debate about software patents in the EU.

Farrell/Shapiro (2004) compare software patents, copyright and trade secrets. They identify two polar viewpoints which represent a fundamental clash of views about the sources of innovation and creativity: the incentives school and the openness school. Furthermore, they argue that copyright may be a strong instrument. If network effects are strong, a copyright including an interface which allows other software to be compatible with the copyrighted software can thus “confer a good deal of market power.”

Yet advocates like opponents of software patents are both amazed that traditional, patent protected sectors like engineering have developed with sustainable growth rates for many years, while the software sector has succeeded to a great extent without patent protection (or without the possibility to enforce attained patents).

A look at the theory of the incomplete contracts may solve this “secret.” In engineering, an invention is mostly dedicated to a specific final product; thus the outside option of the inventor amounts to zero in the worst case. Patents are necessary to stimulate an adequate investment volume. In contrast to this, software modules can be copied and used repeatedly. Therefore, the outside option of a software developer never amounts zero, also stimulating thereby the investment volumes without patents. From this point of view, the introduction of software patents is not economically necessary.

2 Management Decisions of Digital Companies

As previous sections were predominantly related to IT services, the following reflections are dedicated to producers of digital goods. Regarding internationalisation strategies, all general models describe a trade-off between risk of market entry and market opportunities. Digital goods and services change this trade-off. Analyzing the history of eBay, an American online auction company, Mahnke/Venzin (2002) find the following characteristics of digital companies internationalisation strategies:

- Post-entry adaptations (i.e., additional modifications and amendments to the product can be carried out quickly).
- Branding is more important in digital markets. Hence, rather high control modes are chosen, even if doubts because of foreignness and the danger of moral hazard in the foreign market seem to be low.
- The behavior of the customers in the foreign market can be identified and learnt more easily than in traditional markets. Thus, a lower resource commitment is necessary.
- Low investment cost (also with greenfield investment). For this reason, a long-term comparison may give the result that a greenfield investment or a merger & acquisitions transaction have cost advantages in comparison to a joint venture with a unfitting partner.
- The transportation costs are negligible with digital goods. Therefore distance does not matter.

Due to these characteristics, strategies seem suitable for companies with digital products which deviate from the traditional internationalisation strategies. Market entry takes place more rapidly and not step-by-step. Branding requirements lead to a higher entry mode (i.e., a more extensive control), even for a country in which the danger of being fleeced is low. Greenfield investments rather than cooperations may occur.

3 Market Entry of Digital Good Producers in a General Equilibrium Model

At the heart of the model is the idea that only intermediate suppliers with the best quality adjusted price will survive. This corresponds to the description of digital goods as innovative scale markets (in the upper right corner ranking products for knowledge- and scale intensity as in Fig. 1 introduced at the beginning of this chapter).

The model developed offers a second approach to link basic economic data (e.g., size of the economy is equivalent to endowment with labour, elasticity of substitution) to internationalisation strategies. The model is specified to digital good production since one result is the irrelevance of marginal costs. Finally, it analyzes whether a digital company will enter a foreign market and whether this will happen through trade or by acquisition.

The model framework is a general equilibrium model with two sectors and simultaneous Cournot and Bertrand Competition, which follows the approach used by Grossman/Helpman (1991a)[4] . The central argument of the model is described by the following characteristics:

- The aspatial character of digital companies is stressed, as these companies are located in the "rest of the world." The model describes their decision to enter a (new) market of a small, open economy.
- The expected profits are crucial for the internationalisation strategy.
- The revenues are influenced by the quality of the products.
- In the model, the marginal costs of producing digital goods become irrelevant.
- Only one input factor is significant, labour. This stresses the low capital intensity of digital goods production function.

First the framework of a closed economy is developed. For a representative household, a standard CES-utility function is assumed:

$$(11) \quad U = \left(\sum_{j=1}^{n} x_j^{\rho} \right)^{1/\rho}$$

with elasticity of substitutiont $\sigma = \dfrac{1}{1-\rho} > 1$

[4] Chapter 4 - Rising product quality

In the model each of the n different industries produce a final product x. The final products are imperfect substitutes which means that monopolistic competition is predominant in the final goods markets. The budget constraint reads

(12) $E = x_j \, p_j = w_H \, L_H + w_I \, L_I + \prod$

with L_H and L_I representing the labour employed in the sectors sales/marketing H of the final goods and intermediates production I respectively, w_H and w_I signifiying real wage rate in the sectors, p showing the prices of the n different final products x and profits $\prod$ summed up over all companies and sectors.

With regard to the standard assumptions of monopolistic competition (free-entry, Cournot-Competition), a mark up λ results, so that the prices for the final products x_j exceeds their marginal costs by

(13) $\lambda = 1/\rho$

Variable costs of assembling the final goods x_j out of intermediates q and fix costs for marketing add up to the total Cost function C:

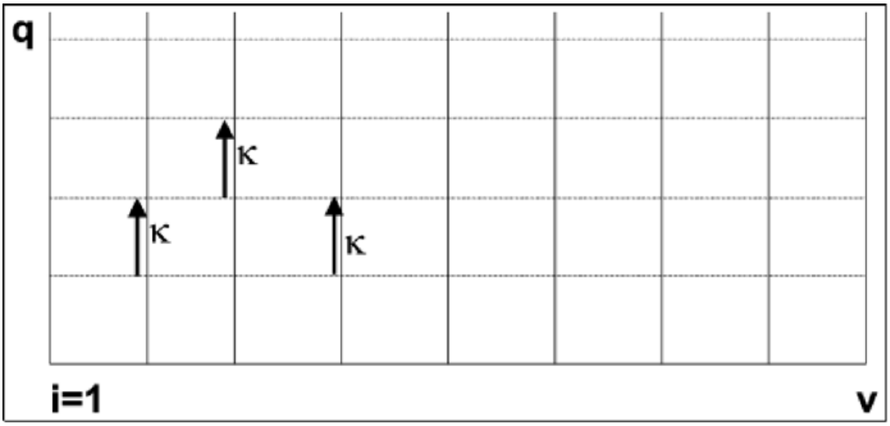
(14) $C_j = Hw_H + v\pi_j x_j$

with H illustrating fixed sales and marketing costs, π the price of the intermediates. The input factor v results from the production function for the final products.

(15) $x_j = \sum_{i=1}^{v_j} \frac{1}{v} z_{j,i}(q_{j,i})$

assuming that $v_j = v = \overline{v}$. For mathematical convenience and without loss of generality, the input factor 1/v balances the number of v different intermediate products z, so that for the production of x units of final product j, exactly z units of the intermediates are used. $q_{j,i}$ indicates the quality of intermediate product $z_{j,i}$.

Following Grossman/Helpman (1991b), a quality ladder as seen in the graph below represents the enhancements achieved when producing the intermediates.



Source: Grossman/Helpman (1991b)

Fig. 66. Quality Ladder for Industry j

The horizontal axis represents the intermediate producers of industry j indexed by i. The quality level q of the intermediates is shown on the vertical axis. Improving quality means developing a next generation version of an intermediate. By assumption, a next generation intermediate provides exactly κ times as much quality (or services) as the product of the generation before it. $\kappa > 1$ is constant and exogenous.

The production function to produce the intermediates z has a fixed component α and variable component with a fixed input factor $1/\beta$:

(16) $z_{j,i} = \alpha + L^{\text{var}}{}_{j,i} / \beta$

Bertrand competition in the market of intermediates for industry j leads to the result that only the company offering the best quality adjusted price will survive: Consider two companies A and B which both offer intermediate i for industry j. They may produce intermediates of quality $q_{j,i,A}$ and $q_{j,i,B}$, respectively. Quality adjusted prices Q are

(17) $Q_{j,i} = \dfrac{\pi_{j,i}}{q_{j,i}}$

The intermediates i for industry j are perfect substitutes. The quality adjusted price is the only criterion for the final goods producer to decide which company should supply the intermediates. With equal quality adjusted prices, it chooses the higher quality product for convenience. Therefore results $z_{j,i,k} = 0$ with $k \in B, C, D, ..$ when $Q_{j,i,A} < Q_{j,i,k}$ for every k. So company A sells all $z_{j,i}$ at price $Q_{j,i,B} = \kappa\, Q_{j,i,A}$, which reflects Bertrand competition in this market segment.

Introducing marginal cost pricing for company B, which yields βw_I with w_I for the real wage in the intermediates producing sector according to (16) the price which has to be paid by the final good producer of industry j to company A, yields marginal costs of B times the factor κ:

(18) $\pi_{j,i} = Q_{j,i,B} q_{j,i,A} = \kappa\beta w_I$

For determining a general solution, some symmetry assumptions are now introduced:

1.) $\beta_{j,i} = \beta$, 2.) $w_{I,j,i} = w_I$ and 3.) $\kappa_{j,i} = \kappa$ for all j,i.

The quality of an intermediate depends on the amount invested in Research & Development, which is measured by α . To agree on producing $z_{j,i}$, company A must achieve a non negative profit $\prod_A \geq 0$:

(19) $\prod_A = z_{j,i}\left[\pi_{j,i} - \frac{\alpha}{z_{j,i}} w_I - \beta w_I\right] = z_{j,i} w_I \left[\kappa\beta - \frac{\alpha}{z_{j,i}} - \beta\right] = z_{j,i} w_I \left[(\kappa-1)\beta\right] - \alpha$

The equilibrium conditions for the labour market finish the description of the closed economy:

(20) $L = L_H + L_I$

(21) $L_H = nH$

(22) $L_I = \sum_{j=1}^{n}\sum_{i=1}^{v_j}(z\beta + \alpha)$

The next step is to transform equation (19) so that profit can be expressed with exogenous variables of the closed economy only. Then the expected profit function of potential new intermediate suppliers can be examined when the closed economy is opened. First, the cost-function is amended by the industry's j pricing model. The expenditure per industry is calculated, which gives solutions for x and z. Assuming symmetry of all n v industries, a general cost function can then be determined.

The total costs involved in producing and selling final products x_j are:

(23) $C_j = Hw_H + v\pi_j x_j = Hw_H + v\beta w_I \kappa x_j$

Marginal costs amount to:

(24) $\frac{\partial C_j}{\partial x_j} = v\beta\kappa w_I$

In equilibrium, the price of the final product equals the marginal costs times the mark-up λ:

(25) $p_j = \lambda v \beta \kappa w_I$

In each industry j the difference between the price and marginal costs is used to cover the fixed costs:

(26) $$H\,w_H = x_j\,(\lambda\, v\, \beta\, \kappa\, w_I - v\,\beta\,\kappa\, w_I)$$

Assuming labour flexibility between all sectors $w_H = w_I = w$ leads to

(27) $$x_i = \frac{H}{(\lambda - 1)\, v\,\beta\,\kappa}$$

The number of industries n is given by the standard solution of monopolistic competition

(28) $$x_j = \frac{p(j)^{1/(\rho-1)}}{\int_0^n p(y)^{1/(\rho-1)}} E = \frac{p(j)^{-\sigma}}{\int_0^n p(y)^{-\sigma} dy} E$$

Symmetry with P(j) = p for all j would directly lead to $x_j = E / (np(j))$. Assuming symmetry for all i it directly follows $x_j = z_{j,i}$ from the production function since the input coefficent 1/v balance the number of digital goods. Inserting the equation determining x_j in the profit function:

(29) $$\Pi_A = \frac{Hw(\kappa - 1)}{(\lambda - 1)\, v\,\kappa} - \alpha = H\,w\left[\frac{1}{(\lambda - 1)v} - \frac{1}{(\lambda - 1)v\kappa}\right] - \alpha$$

When w = 1 is choosen as numeraire the equation express the expected profit in terms of exogenous variables only. The model specification leads to the result that the marginal costs β are irrelevant, which reproduces a main characteristic of a digital economy. The interpretation of the equation is intuitive:

- Technological leadership positively affects profits.

  $$\frac{\partial \Pi_A}{\partial \kappa} > 0$$

- The higher the number of intermediate goods producers in an industry, the lower the profit will be.

  $$\frac{\partial \Pi_A}{\partial \upsilon} < 0$$

- The higher the fixed costs of the final goods provider the more profitable are investments in Research and Development by the digital goods producer:

  $$\frac{\partial(\partial \Pi_A / H)}{\partial \kappa} > 0$$

Opening the economy changes the perspective to consider a single company F outside this country, whose headquarters is located “somewhere” in the rest of world (or is aspatial in this sense). The production function of F corresponds to (16). Moreover μ denotes the additional marketing and sales costs for market entry in the closed economy and ψ describes the probability of having success, which means that the domestic competitor A for variety I can be squeezed out:[5]

1. Strategy 1: F enters the market and offers its own digital products as intermediates. Transport costs are neglected because of the special characteristics of digital goods. Assuming that the product is developed already, which means the fixed costs α are not relevant for the decision on market entry, the profit function then yields:

$$(30)\ \prod_{foreign} = \psi \left[\frac{H\left(\kappa - 1\right)}{(\lambda - 1)\nu\kappa} \right] - \mu$$

2. Strategy 2: The foreign company F buys domestic company A. K is the price of the acquisition, ρ the discount factor for the next period's profits and $(1-\psi)^{i_t^*}$ describes the probability that not one of the competitors will be successful till t.

$$(31)\ \prod_{foreign} = K - \sum_{t=1}^{\infty} \left[(1-\psi)^{i_t^*} \frac{H\left(\kappa - 1\right)}{(\lambda - 1)\nu\ \kappa} - \alpha \right] \rho^{-t}$$

3. Strategy 3: Do nothing

$$(32)\ \prod_{foreign} = 0$$

Equations (30) to (32) predict the internationalisation strategies of digital goods producers:

- A high H and a low λ are preferred by foreign digital goods producers to enter in. Interpreting the necessary marketing consts H as a proxy for the size of the country leads to the result, that larger countries are more attractive for foreign digital goods producers.
- Strategy 2 (acquisition) is chosen, when technological leadership of the domestic price-quality leadership is dominant and sustainable and the risk of not achieving the leader position oneself is high.

The price-quality competition is pivotal in this model. Interpreting the enhancement process of versions as raising the knowledge-intensity of a product, the model predicts that competition drives digital goods producers to the right upper corner of the knowledge-scale-intensity diagram introduced above.

In reality all strategies can be observed. Anecdotic evidence may be that Microsoft tends to conduct strategy 1 since it has a strong technological leadership position in operating systems (high κ) and therefore prefers growing through trade. Whereas eBay in the early years pursued a mixed strategy; in countries with competitors in its market segments (e.g., Germany), it prepared the ground through

[5] For convenience, it is assumed that the company F is the only potential competitor and that F is "small" in the sense that possible disequilibria in the balance of payments can be neglected.

acquisitions. Whereas the hypothesis for SAP may be that it prefers large countries due to a high μ .

4 Comparing the Models for IT Services and Digital Goods Providers

Comparing the presented models in the previous sections shows that IT service and digital companies behave heterogeneously from a theoretical point of view. A main distinction depends on the relationship of IT service and digital goods providers to their customers. Does internationalisation mean accompanying an existing (domestic) customer when entering foreign markets or does internationalisation mean to search for new customers?

Evidence for both scenarios is exemplarily given by the case studies of the software producers F-Secure, SAP and FreeSoft:

- FreeSoft –IT Service company which offers custom software applications.
- SAP –IT Service company which has accompanied European (German) companies from the beginning. Today, service fees (maintaining) contribute to SAP's total revenues more than subscription and licensing fees.
- F-Secure – Digital Goods producer; subscription fees and licensing fees contribute to F-Secure's total revenues more than the service fees.

In their theoretical structures both approaches are quite different, although they share some theoretic elements such as monopolistic competition (see Table 26 above for a comparison). One important insight for economic policy may be the different relevance of innovations for the described internationalisation strategies. Planning market entry by looking for new customers in new markets requires having innovative products or services to become price-quality leader. On the other hand, when accompanying multinational companies, an IT service company may find that other factors such as enforcing customer's loyalty may be more important.

Finally, reference should be made to the model by Grossman/Helpman (2002a). It is a general equilibrium model of a closed economy which has elements of both models presented here (incomplete contracts, final and intermediate goods producer, and expected profit functions which are crucial for the organizational structure in the economy). The "make or buy"-decision of the final goods producer means solving the trade-off between risk and search-costs on the one hand and production costs on the other. Outsourcing of the intermediate production is more plausible, the lower the elasticity of substitution between the final products and the larger the considered economy.

Table 26. Comparison of Presented Models

Comparison	Administration rights approach in combination with general equilibrium approach	Opening closed economy in general equilibrium model for aspatial digital companies located in RoW
Focus	International favoured structure of IT systems architecture.	Internationalisation strategy of digital goods producer
Key driver for internationalisation	Accompanying multinational companies or supporting outsourcing solutions	Searching for new markets
Incorporated in model by	Incomplete contracts	Bertrand price competition in intermediate goods market
Main criterion for company's interna-tionalization strategy	IT systems architecture required due to endogenously determined organizational structure	Expected profit in new market
Main result	Twofold: a) IT as self-contained intermediate: outsourcing solutions are favoured in labour rich countries b) IT as service accompanying internationalizing companies: In labour intensive industries manufactures keep their own IT systems and IT has to provide standardized interfaces. Local IT suppliers are employed. But in capital intensive industries vertically integrated companies favour proprietary systems and prefer to be accompanied by their domestic IT service supplier.	Export of digital goods (= offshoring from point of view of importing country) when the risk of not obtaining the price-quality-leadership is low. Large markets are first exposed to import competition. Marginal costs are irrelevant for the market entry decision ('the winner takes it all').
Innovation (=quality of products)	Innovations in IT are not pivotal for the internationalisation of IT service companies. More important is the organizational firm-structure.	Innovation lead to technological leadership which is crucial for internationalisation.

Appendix A.II Additional Tables and Figures - Chapter II

Table 27. Worldwide Telecommunication Market Growth Trends (market value in million at constant 2003 exchange rates)

€ million	2002	2003	2004	2005	2006
Europe	311,863	322,018	333,811	346,089	357,496
US	233,158	233,256	235,991	243,334	251,110
Japan	156,694	155,989	159,667	164,205	168,039
Rest of World	310,272	327,055	349,418	372,537	402,886
Total	**1.011,986**	**1.038,318**	**1.078,887**	**1.126,165**	**1.179,531**

			% breakdown		
Europe	30,8	31,0	30,9	30,7	30,3
US	23,0	22,5	21,9	21,6	21,3
Japan	15,5	15,0	14,8	14,6	14,2
Rest of World	30,7	31,5	32,4	33,1	34,2
Total	**100,0**	**100,0**	**100,0**	**100,0**	**100,0**

			% growth		
Europe	3,1	3,3	3,7	3,7	3,3
US	2,8	0,0	1,2	3,1	3,2
Japan	6,8	-0,4	2,4	2,8	2,3
Rest of World	6,3	5,4	6,8	6,6	8,1
Total	**4,5**	**2,6**	**3,9**	**4,4**	**4,7**

Source: European Information Technology Observatory (2005), p. 211

Table 28. Worldwide ICT Market Growth Trends (market value in million at constant 2003 exchange rates)

			% growth		
Total	**0,7**	**1,4**	**3,7**	**4,3**	**4,8**

Source: European Information Technology Observatory (2005), p. 211

Table 29. US Total Employment by Occupation, Total and Computer Occupations, 1997-2004 (Thousands and Percentage)

	All occupations	Computer and mathematical occupations	of which: Computer systems analysts and scientists
A. Thousands			
1997	129558	1494	1236
1998	131463	1747	1471
1999	133488	1847	1549
2000	135208	2074	1797
2001	135073	2103	1810
2002 2002-Dec	136485 136599	2030 3163	1742 ...
2003-Dec	138556	3183	...
2004-Dec	140278	3357	...
B. Percentage change (annual)			
1998	1.5	16.9	19.0
1999	1.5	5.7	5.3
2000	1.3	12.3	16.0
2001	-0.1	1.4	0.7
2002 2003-Dec[a]	1.0 1.4	-3.5 0.6	-3.8 ...
2004-Dec	1.2	5.5	...
1997-2000	1.4	11.6	13.3

a Break in series
Source: WTO World Trade Report 2005

Table 30. Hourly Wages of Computer Systems Analysts in the United States, 1997-2004(Dollars)

Year	All occupations (a)	Computer systems analysts and scientists (b)	Relative wage of computer systems analysts and scientists (b):(a)
1997 (Sept)	15.09	26.79	1.78
1998 (Dec)	15.72	27.89	1.77
1999 (Sept)	15.36	28.49	1.85
2000 (July)	15.80	29.26	1.85
2001 (Jan)	16.23	30.33	1.87
2002 (July)	17.18	32.86	1.91
2003 (July)	17.75	33.25	1.87

Source: WTO World Trade Report 2005

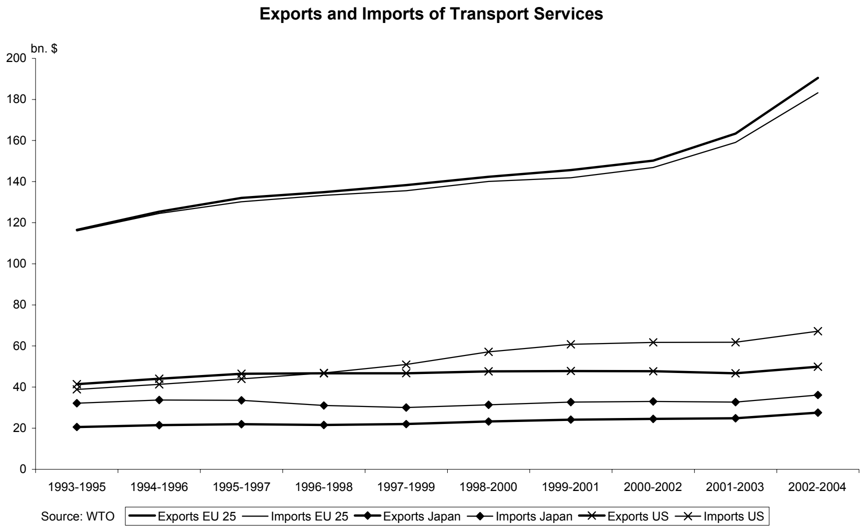


Fig. 67. Exports and Imports of Transport Services (Three Year Moving Averages)

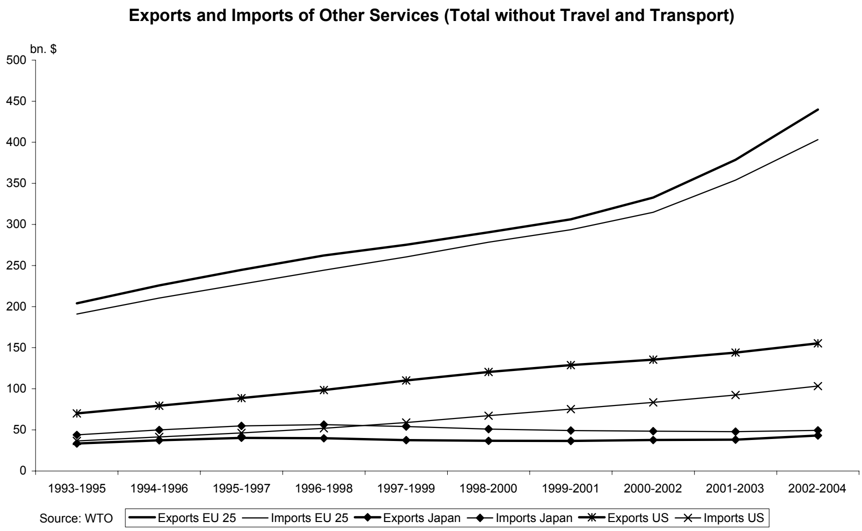
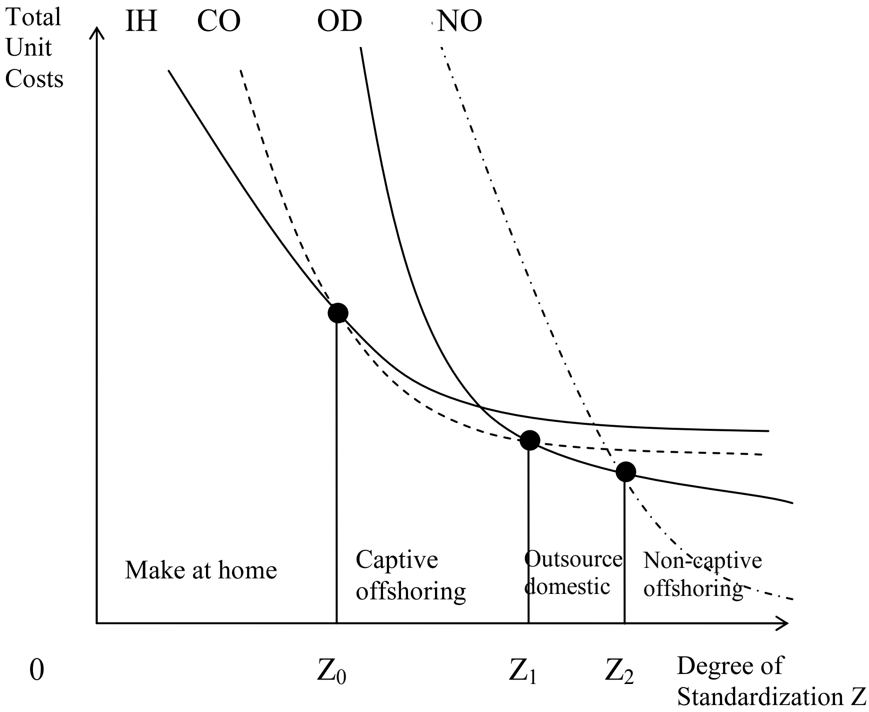


Fig. 68. Exports and Imports of Other Services (Total without Travel and Transport)

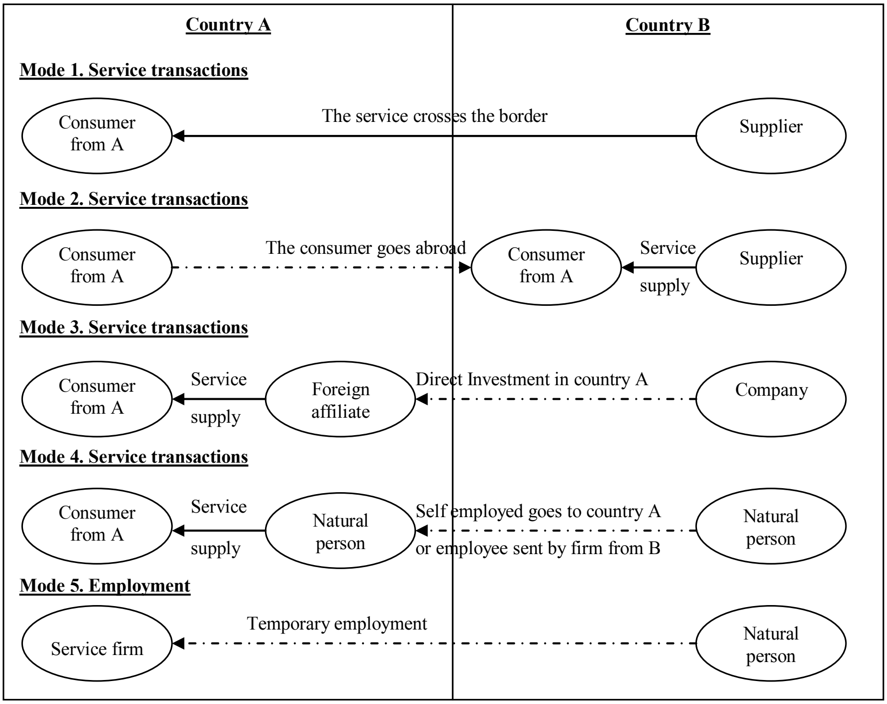


(Mix of Fixed Management Costs and other Costs) and Outsourcing Dynamics According to Antras/Helpman (2004) [IH=In-house, CO= captive offshoring; OD= outsource domestic; NO= non-captive offshore]

Fig. 69. Total Unit Cost

Table 31. Wages of Software Engineers (in Euro; according to Siemens)

Germany	56.5 €
USA	52.1 €
Austria	41.9 €
UK	30.4 €
Hungary	28.9 €
Singpore	26.9 €
Israel	24.8 €
Brazil	15.5 €
Slovakia	13.0 €
India	6.8 €



Source: UN (2002)

Fig. 70. GATS Modes of Service Trade

Table 32. OECD Price Basket Telecommunication Services for Consumers Houaseholds (incl. VAT), August 2004

	Fixed		Usage		Total	
	USD	USD PPP	USD	USD PPP	USD	USD PPP
Australia	251,02	251,02	490,12	490,12	741,14	741,14
Austria	261,94	238,12	294,68	267,89	556,62	506,02
Belgium	273,84	246,70	383,49	345,49	657,33	592,19
Canada	292,32	317,74	183,57	199,53	475,88	517,26
Czech Republic	283,52	497,41	172,45	302,55	455,98	799,96
Denmark	268,72	189,24	306,87	216,11	575,59	405,35
Finland	229,10	178,99	469,53	366,82	698,63	545,80
France	204,09	179,03	420,81	369,13	624,90	548,15
Germany	243,22	213,35	346,19	303,67	589,41	517,02
Greece	192,03	200,03	382,04	397,96	574,07	597,99
Hungary	281,63	440,04	475,74	743,35	757,37	1 183,39
Iceland	191,58	136,85	338,19	241,57	529,78	378,41
Ireland	377,48	288,16	288,03	219,87	665,51	508,02
Italy	236,86	225,58	353,60	336,76	590,46	562,34
Japan	233,28	163,13	488,81	341,83	722,09	504,96
Korea	64,73	91,16	326,61	460,01	391,33	551,17
Luxembourg	286,94	256,19	205,31	183,31	492,25	439,51
Mexico	220,31	305,99	450,89	626,24	671,20	932,23
Netherlands	280,67	246,20	291,29	255,51	571,96	501,72
New Zealand	319,86	351,49	358,60	394,06	678,46	745,56
Norway	314,04	218,09	300,13	208,42	614,17	426,51
Poland	162,14	305,92	488,42	921,56	650,56	1 227,47
Portugal	244,42	290,98	431,43	513,61	675,85	804,59
Slovak Republic	116,33	197,16	391,41	663,41	507,74	860,57
Spain	243,47	256,28	306,35	322,47	549,81	578,75
Sweden	220,46	173,59	270,33	212,86	490,79	386,45
Switzerland	251,23	166,38	350,90	232,38	602,13	398,76
Turkey	95,06	161,12	514,01	871,20	609,07	1 032,32
United Kingdom	245,88	211,97	256,57	221,18	502,46	433,15
United States	228,58	228,58	409,11	409,11	637,69	637,69
OECD	237,16	240,88	358,18	387,93	595,34	628,82

Note: Composite basket includes international calls and calls to mobile networks.

Source: OECD and Teligen.

dx.doi.org/10.1787/387326833742

Table 33. OECD Price Basket Telecommunication Services for Companies (excl. VAT), August 2004

	Fixed		Usage		Total	
	USD	USD PPP	USD	USD PPP	USD	USD PPP
Australia	290,74	290,74	1 331,40	1 331,40	1 622,13	1 622,13
Austria	279,42	254,02	1 195,90	1 087,18	1 475,32	1 341,20
Belgium	226,32	203,89	1 168,06	1 052,30	1 394,37	1 256,19
Canada	380,14	413,20	588,28	639,44	968,42	1 052,63
Czech Republic	355,61	623,87	794,42	1 393,72	1 150,03	2 017,59
Denmark	214,98	151,39	823,38	579,84	1 038,35	731,24
Finland	192,24	150,19	1 203,27	940,05	1 395,51	1 090,25
France	258,54	226,79	1 052,00	922,81	1 310,54	1 149,60
Germany	209,67	183,92	1 174,20	1 030,00	1 383,87	1 213,93
Greece	162,73	169,51	909,51	947,41	1 072,25	1 116,92
Hungary	330,26	516,04	1 335,88	2 087,31	1 666,14	2 603,34
Iceland	257,43	183,88	711,51	508,22	968,94	692,10
Ireland	311,97	238,15	959,64	732,55	1 271,61	970,70
Italy	278,68	265,41	1 054,69	1 004,46	1 333,37	1 269,88
Japan	314,29	219,78	1 458,09	1 019,64	1 772,38	1 239,43
Korea	58,84	82,87	825,69	1 162,95	884,54	1 245,83
Luxembourg	249,51	222,78	640,42	571,81	889,93	794,58
Mexico	239,93	333,23	1 695,79	2 355,27	1 935,72	2 688,50
Netherlands	235,86	206,89	839,56	736,46	1 075,42	943,35
New Zealand	473,94	520,81	960,78	1 055,80	1 434,71	1 576,61
Norway	253,26	175,88	762,77	529,70	1 016,03	705,58
Poland	132,90	250,75	1 252,06	2 362,37	1 384,95	2 613,12
Portugal	205,40	244,52	1 115,69	1 328,20	1 321,08	1 572,72
Slovak Republic	134,55	228,05	1 157,32	1 961,57	1 291,88	2 189,62
Spain	209,89	220,93	846,05	890,58	1 055,94	1 111,51
Sweden	204,07	160,68	749,23	589,95	953,30	750,63
Switzerland	233,48	154,63	1 157,13	766,31	1 390,62	920,94
Turkey	80,56	136,54	1 291,13	2 188,36	1 371,69	2 324,90
United Kingdom	321,50	277,15	1 402,00	1 208,62	1 723,50	1 485,77
United States	274,29	274,29	882,81	882,81	1 157,10	1 157,10
OECD	245,70	252,69	1 044,62	1 128,90	1 290,32	1 381,60

Source: OECD and Teligen.

dx.doi.org/10.1787/650826436255

Table 34. OECD Price Basket for International Telecommunication Services, August 2004

	Business (excluding VAT)		Residential (including VAT)	
	USD PPP	USD	USD PPP	USD
Australia	1,06	1,06	1,48	1,48
Austria	0,96	1,06	1,11	1,22
Belgium	0,68	0,75	0,80	0,89
Canada	0,83	0,76	1,16	1,07
Czech Republic	0,77	0,44	1,17	0,67
Denmark	0,47	0,67	0,75	1,06
Finland	0,88	1,12	1,11	1,42
France	0,46	0,53	0,85	0,97
Germany	0,50	0,57	0,75	0,86
Greece	1,12	1,07	1,69	1,63
Hungary	1,68	1,07	2,68	1,72
Iceland	0,63	0,89	1,00	1,40
Ireland	0,50	0,66	0,72	0,94
Italy	0,97	1,02	1,40	1,47
Japan	1,99	2,85	2,00	2,85
Korea	2,51	1,78	3,37	2,39
Luxembourg	0,45	0,51	0,61	0,69
Mexico	3,78	2,72	4,59	3,30
Netherlands	0,43	0,49	0,63	0,71
New Zealand	1,29	1,17	1,76	1,60
Norway	0,25	0,35	0,37	0,54
Poland	2,20	1,17	3,45	1,83
Portugal	1,17	0,98	1,61	1,35
Slovak Republic	1,08	0,64	2,51	1,48
Spain	0,72	0,68	1,02	0,97
Sweden	0,32	0,41	0,50	0,64
Switzerland	0,24	0,37	0,31	0,46
Turkey	1,98	1,17	3,00	1,77
United Kingdom	1,42	1,65	0,85	0,98
United States	0,55	0,55	0,49	0,49
OECD	1,06	0,97	1,46	1,29

Note: Average call charge for one single call, weighted by traffic.
Source: OECD and Teligen.
dx.doi.org/10.1787/643236034261

Table 35. Prices for DSL-Connections in Selected OECD Countries, 2002–2004 (incl. Tax)

	Price change 2002 to 2004, USD	Price change 2002 to 2004, USD PPP	Change in data transfer (megabytes)	Change in data transfer price per megabyte, USD	Change in data transfer price per megabyte, USD	Change in capacity downstream (kbps)	Change in capacity upstream (kbps)
Australia	6,55	2,15	300 Mb to unlimited	-0,09	-0,11	0	0
Austria	-5,89	-10,38	-500	0,01	0,00	256	64
Belgium	6,08	0,61	0	-0,12	-0,13	2 550	64
Canada	12,20	13,00	5000 Mb to unlimited	0,00	-0,01	2 040	200
Denmark	7,75	1,40	0	0,00	0,00	256	0
Finland	-13,81	-13,59	0	0,00	0,00	0	0
France	-15,10	-19,80	0	0,00	0,00	0	0
Germany	-13,51	-18,59	Unlimited to 1500 MBb	0,02	0,02	256	0
Hungary	-16,82	-33,07	0	0,00	0,00	128	64
Iceland	18,88	14,39	Unlimited domestic	-0,11	-0,10	768	0
Ireland	-60,06	-64,04	1000	0,01	0,00	0	0
Italy	-7,03	-15,39	0	0,00	0,00	0	128
Japan	-0,07	4,36	0	0,00	0,00	6 500	512
Korea	-2,12	0,08	0	0,00	0,00	2 500	3 360
Luxembourg	-18,87	-28,63	Unlimited to 1000 Mb	0,00	0,00	768	64
Mexico	-21,09	-20,30	0	0,00	0,00	0	0
Netherlands	-9,34	-14,47	NA	NA	NA	160	96
New Zealand	-8,76	-19,92	500	NA	NA	-1 744	- 122
Norway	-12,17	-7,60	0	0,00	0,00	320	0
Poland	-28,23	-48,77	Unlimited to 5000 Mb	0,00	0,00	0	0
Portugal	2,44	-1,89	16000	-0,11	-0,16	0	0
Spain	3,62	-3,67	0	0,00	0,00	0	0
Sweden	1,27	-2,40	0	0,00	0,00	0	0
Switzerland	2,73	-0,03	3000 Mb to unlimited	-0,03	-0,03	344	36
Turkey	-58,82	-147,90	0	0,00	0,00	0	0
United Kingdom	-12,84	-12,63	Unlimited to 1000 Mb	0,00	0,00	0	0
United States	-10,00	-10,00	0	0,00	0,00	732	256
Average of above	-9,37	-16,93				586	175

Note: The offers compared are those in the first line for each country in Table 6.5.

dx.doi.org/10.1787/100645627805

Table 36. Prices for Internet Access via Cable in Selected OECD Countries, January 2005

Country	ISP	Download speed (kbps)	Upload speed (kbps)	Monthly subscription (USD)	Telephony available
Canada	Rogers	256	64	29,14	No (2005)
Canada	Shaw	300	..	24,97	No (2005)
Canada	Rogers	5 000	800	45,82	No (2005)
Canada	Shaw	5 000	..	44,15	No (2005)
Finland	Welho	1 000	300	47,01	No
Finland	Welho	2 000	400	60,07	No
Finland	Welho	3 000	500	71,82	No
Finland	Welho	10 000	500	90,10	No
Germany	Primacom	768	256	25,99	No (2005)
Germany	Primacom	2 048	256	50,93	No (2005)
Germany	Primacom	4 096	256	90,10	No (2005)
Japan	Jcom	8 000	2 000	48,38	Yes
Japan	Jcom	30 000	2 000	53,43	Yes
Korea	Thrunet	10 000	800	35,56	..
Korea	Hanaro	10 000	800	31,82	Yes
Netherlands	UPC	256	64	19,52	Yes
Netherlands	UPC	2 048	512	43,03	Yes
Netherlands	UPC	4 096	1 024	65,23	Yes
Netherlands	UPC	8 192	1 024	104,40	Yes
Sweden	Comhem	1 000	200	51,04	Yes
Sweden	Comhem	2 000	400	57,61	Yes
Sweden	Comhem	8 000	1 000	64,90	Yes
United States	Comcast	4 000	384	56,99	Yes
United States	Earthlink	5 000	384	59,95	Yes
United States	Roadrunner	5 000	384	59,95	Yes
United States	Comcast	6 000	768	56,99	Yes

dx.doi.org/10.1787/388107063305

Appendix B Data Issues Related to Chapter III

A Note on the Data Used in Chapter III

In the context of this chapter, the competitive position of a country on the global market regarding a certain product or service is often measured by revealed competitive advantage (RCA). In this case, positive revealed comparative advantage means sectoral strength, especially in medium and high technology sectors as ICT activities. Therefore, we use RCAs as a measure of competitiveness of a country in this empirical part of the study. By using RCA as a proxy to express a country's competitive edge in a certain market, we experienced severe data limitations which prevented us from using much of the detailed and specific data on ICT activities that we intended to use at the start of this project. The actual use of databases in empirical research is oftentimes disappointing because of 'holes' and uneven coverage of periods of time and other inconveniences. However, an exceptionally good statistical source on trade in goods is Eurostat's Comext trade database. Volume and value of traded goods between 28 exporting and 263 partner countries is available for each month from January 1993 onwards. Another example of a useful database is the 60-industry database of the Groningen Growth Centre. This database contains information about labour productivity and prices of 60 industries including the following 6 ICT industries we define here: Office, accounting & computing machinery (ISIC 30), Radio and television & communication equipment (ISIC32), Medical, precision and optical instruments (ISIC33), Post & Telecommunication (ISIC64), Computer & related services (ISIC72), and (Part of) Research and other business services (ISIC 73-74). However, when it comes to foreign direct investment and educational attainment or skill levels of the labour force, emphasised as important factors in the theoretical part of this study, the data sources indeed show a greater number of 'holes'. Foreign direct investment of the ICT sectors and costs such as, wages in the sectors of activity, are often available for a small selection of countries, too small to base robust calculations on. Although trade with countries such as, China and India is taken into account, it was not possible to explain these developments by an investigation of underlying forces which is also due to severe data limitations. India as an important ICT service provider is absent in the Balance of Payment Statistics of the IMF as it comes to ICT and information services. Therefore, the choice of countries and the period covered is necessarily also determined by data availability which is especially the case for ICT services.

SITC Rev 3 Activity and Product Classification

SITC REV 3. Activity Classification

ICT activities or the 'ICT industry', including research and development, is defined in this chapter as the following 2-digit ISIC industries. It is not a product classification (i.e. enterprises producing certain ICT products are classified not products), hence it is a classification based on activities such as:

- Office, accounting & computing machinery (ISIC 30),
- Radio and television & communication equipment (ISIC 32),
- Medical, precision and optical instruments (ISIC 33),
- Post & Telecommunication (ISIC 64),
- Computer & related services (ISIC 72), and/or
- (Part of) Research and other business services (ISIC 73-74).

We use the SITC product classification for international trade in ICT products,.

SITC REV 3. Product classification

7 - Machinery and transport equipment

75 - Office machines and automatic data-processing machines

751 - Office machines

752 - Automatic data-processing machines and units thereof; magnetic or optical readers, machines for transcribing data onto data media in coded form and machines for processing such data, n.e.s.

759 - Parts and accessories (other than covers, carrying cases and the like) suitable for use solely or principally with machines falling within groups 751 and 752

76 - Telecommunications and sound-recording and reproducing apparatus and equipment

761- Television receivers (including video monitors and video projectors), whether or not incorporating radio-broadcast receivers or sound- or video-recording or reproducing apparatus

762 - Radio-broadcast receivers, whether or not incorporating sound-recording or reproducing apparatus or a clock

763 - Sound recorders or reproducers; television image and sound recorders or reproducers; prepared unrecorded media

764 - Telecommunications equipment, n.e.s., and parts, n.e.s., and accessories of apparatus falling within division 76

77 - Electrical machinery, apparatus and appliances, n.e.s., and electrical parts thereof (including non-electrical counterparts, n.e.s., of electrical household-type equipment)

771 - Electric power machinery (other than rotating electric plant of group 716), and parts thereof

772 - Electrical apparatus for switching or protecting electrical circuits or for making connections to or in electrical circuits (e.g., switches, relays, fuses, lightning arresters, voltage limiters, surge suppressors, plugs and sockets,

lamp-holders and junction boxes); electrical resistors (including rheostats and potentiometers), other than heating resistors; printed circuits; boards, panels (including numerical control panels), consoles, desks, cabinets and other bases, equipped with two or more apparatus for switching, protecting or for making connections to or in electrical circuits, for electric control or the distribution of electricity (excluding switching apparatus of subgroup 764.1)

773 - Equipment for distributing electricity, n.e.s.

774 - Electrodiagnostic apparatus for medical, surgical, dental or veterinary purposes, and radiological apparatus

775 - Household-type electrical and non-electrical equipment, n.e.s.

776 - Thermionic, cold cathode or photo-cathode valves and tubes (e.g., vacuum or vapour or gas-filled valves and tubes, mercury arc rectifying valves and tubes, cathode-ray tubes, television camera tubes); diodes, transistors and similar semiconductor devices; photosensitive semiconductor devices; light-emitting diodes; mounted piezoelectric crystals; electronic integrated circuits and micro assemblies; parts thereof

778 - Electrical machinery and apparatus, n.e.s.

87 - Professional, scientific and controlling instruments and apparatus, n.e.s.

871 - Optical instruments and apparatus, n.e.s.

872 - Instruments and appliances, n.e.s., for medical, surgical, dental or veterinary purposes

873 - Meters and counters, n.e.s.

874 - Measuring, checking, analysing and controlling instruments and apparatus, n.e.s

88 - Photographic apparatus, equipment and supplies and optical goods, n.e.s.; watches and clocks

881 - Photographic apparatus and equipment, n.e.s.

882 - Photographic and cinematographic supplies

883 - Cinematographic film, exposed and developed, whether or not incorporating soundtrack or consisting only of soundtrack

884 - Optical goods, n.e.s.

885 - Watches and clocks

Databases Used in Chapter III

Source #	Sources
[1]	[1a]EUROSTAT, COMEXT, dataset: EU trade since 1995 by SITC DS 018995 [1b] EUROSTAT, NEW CRONOS database
[2]	Groningen Growth Centre database[1]
[3]	OECD ANBERD[2]
[6]	[6a] OECD, STAN database [6b] STAN bilateral trade database, Vol 2005, release 01, ISIC Rev 3.
[7]	[7a]OECD FDI data [7b] Balance of Payment Statistical Yearbook IMF [7c] UNCTAD world investment report (WIR, 2004)
[10]	ITU database, 2004
[11]	OECD ITCS International Trade by Commodity Database Edition (ISSN 1608-1218)

A note on the data used for this chapter: the quantitative element for the databases in this chapter were fed. We eventually abandoned the panel estimates based on these data because the results were extremely difficult to interpret, from an economical as well as statistical point of view. These disappointing results were most likely due to low data quality coupled with the small sample.

[1] The usual coverage of the countries is 1979- 2002/3, with the exception of Czech Republic, Hungary, Slovakia, and Poland, which have coverage of 1993-2002. The following industries are distinguished: Office machinery, Insulated wire, Other electrical machinery and apparatus nec, Electronic valves and tubes, Telecommunication equipment, Radio and television receivers, Scientific instruments, Other instruments Communications, Computer and related activities, Research and development. These industries cover the ICT sector as we defined it above. This is compatible with ISIC Rev 3.

[2] Data on R&D covering 1979-1998 of ISIC Rev 3 industries comparable with OECD STAN

Appendix C Detailed Regression Results - Chapter IV

Table 37. Regression Model for the Outward FDI/VA-Ratios

Dependent Variable: LOG(outward FDI/VA)
Method: Least Squares
Sample: 1 60
Included observations: 59
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2.401785	0.777301	-3.089903	0.0045
T2	1.054831	0.207391	5.086191	0.0000
DFR	1.229961	0.983076	1.251136	0.2212
DNL	3.341961	0.783141	4.267379	0.0002
DAT	-0.385618	0.772666	-0.499075	0.6216
DUK	0.982850	0.802968	1.224021	0.2311
S2	0.606322	0.783663	0.773702	0.4456
S3	-0.731369	1.555090	-0.470306	0.6418
S4	-1.365775	0.908170	-1.503876	0.1438
S5	-1.573423	0.864260	-1.820544	0.0794
S6	1.591065	0.771928	2.061158	0.0487
DFR*S2	-1.081856	1.206033	-0.897037	0.3773
DFR*S3	-0.565602	1.670924	-0.338497	0.7375
DFR*S4	0.529838	1.188923	0.445645	0.6593
DFR*S5	-1.964201	1.812379	-1.083769	0.2877
DFR*S6	-1.460343	0.997690	-1.463724	0.1544
DNL*S2	-0.305683	0.840217	-0.363815	0.7187
DNL*S3	-1.463861	1.562583	-0.936821	0.3569
DNL*S4	-1.247194	0.934889	-1.334056	0.1929
DNL*S5	-1.200795	0.892647	-1.345207	0.1894
DNL*S6	-5.507990	0.803179	-6.857734	0.0000
DAT*S2	-0.577903	0.788250	-0.733147	0.4696
DAT*S3	-1.418863	1.559688	-0.909710	0.3707
DAT*S4	-1.352732	0.982939	-1.376211	0.1797
DAT*S5	-0.009673	0.869922	-0.011120	0.9912
DAT*S6	0.093344	0.799801	0.116709	0.9079
DUK*S2	-3.038039	0.822999	-3.691423	0.0010
DUK*S3	1.174275	2.163549	0.542754	0.5916
DUK*S4	0.13716	0.979917	0.139972	0.8897

Table 38. Regression Model for the Inward FDI/VA-Ratios

Dependent Variable: LOG(inward FDI/VA)
Method: Least Squares
Sample: 1 72
Included observations: 70
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.604459	0.228895	-7.009601	0.0000
T2	0.831456	0.121918	6.819791	0.0000
DFR	0.425238	0.424191	1.002468	0.3234
DNL	2.172485	0.239847	9.057792	0.0000
DAT	-3.509580	0.258351	-13.58456	0.0000
DPT	-1.772092	0.226805	-7.813299	0.0000
DUK	1.031970	0.500914	2.060176	0.0473
S2	0.383169	0.230392	1.663117	0.1058
S3	-2.278470	0.950888	-2.396150	0.0224
S4	-1.864939	0.395827	-4.711505	0.0000
S5	-2.994731	0.231299	-12.94742	0.0000
S6	1.255296	0.241223	5.203882	0.0000
DFR*S2	-0.522646	0.447320	-1.168393	0.2510
DFR*S3	0.019069	1.191982	0.015998	0.9873
DFR*S4	-0.063405	0.610830	-0.103802	0.9180
DFR*S5	0.215142	0.435591	0.493909	0.6246
DFR*S6	-0.766782	0.497230	-1.542108	0.1326
DNL*S2	-0.412283	0.392328	-1.050864	0.3010
DNL*S3	0.403421	1.089461	0.370294	0.7135
DNL*S4	-0.268930	0.413186	-0.650867	0.5196
DNL*S5	-0.404579	0.254614	-1.588990	0.1216
DNL*S6	-4.645175	0.259167	-17.92347	0.0000
DAT*S2	3.705219	0.273615	13.54174	0.0000
DAT*S3	5.447922	0.968689	5.624016	0.0000
DAT*S4	3.754403	0.784506	4.785693	0.0000
DAT*S5	4.361844	0.294307	14.82071	0.0000
DAT*S6	3.049398	0.297110	10.26354	0.0000
DPT*S2	2.607828	0.397113	6.566963	0.0000
DPT*S3	3.23645	0.993727	3.256882	0.0026

Appendix D - Chapter V

Classification of ICT Technologies in the International Patent Classification

Semiconductors:
H01L

Telecommunications:
G01S,G08C,G09C,H01P,H01Q,H01S3/(025,043,063,067,085,0933,0941,103,133, 18,19,25),H1S5,H03B,H03C,H03D, H03H, H03M, H04B, H04J, H04K, H04L, H04M, H04Q

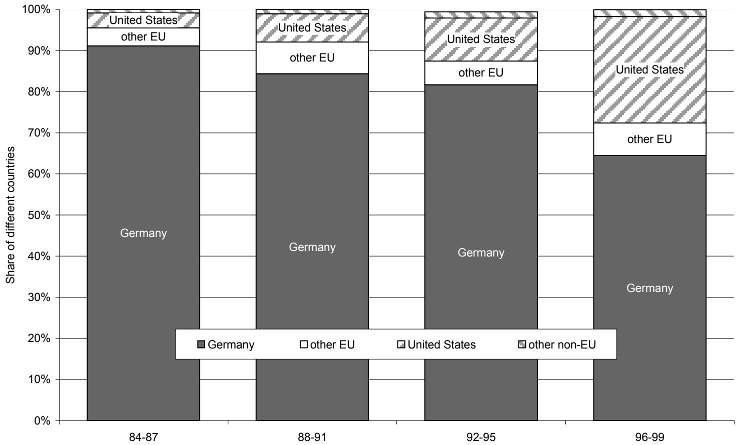
Consumer Electronics:
G11B, H03F, H03G, H03J, H04H, H04N, H04R, H04S

Computers, Office machinery:
B07C, B41J, B41K,G02F,G03G,G05F,G06,G07,G09G,G10L,G11C,H03K,H03L

Other ICT:
G01B, G01C, G01D, G01F, G01G, G01H, G01J, G01K, G01L, G01M, G01N, G01P, G01R, G01V, G01W, G02B6,
G05B, G08G, G09B, H01B11, H01J
(11/,13/,15/,17/,19/,21/,23/,25/,27/,29/,31/,33/,40/,41/,43/,45/)

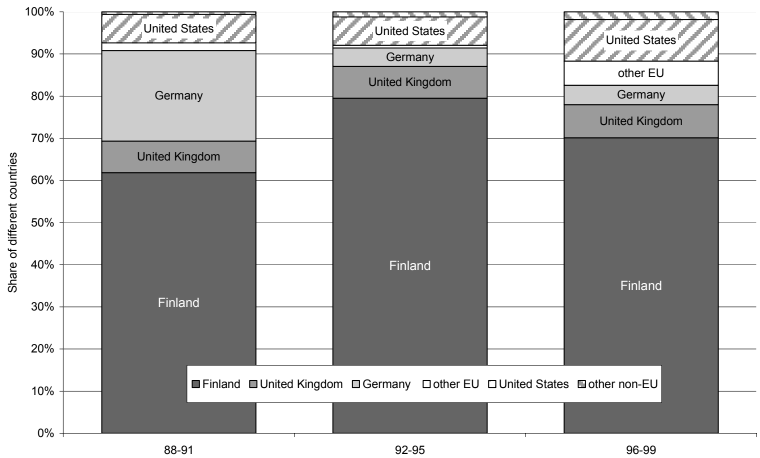
Source: OECD Patent Compendium of Patent Statistics, p. 16

Additional Figures



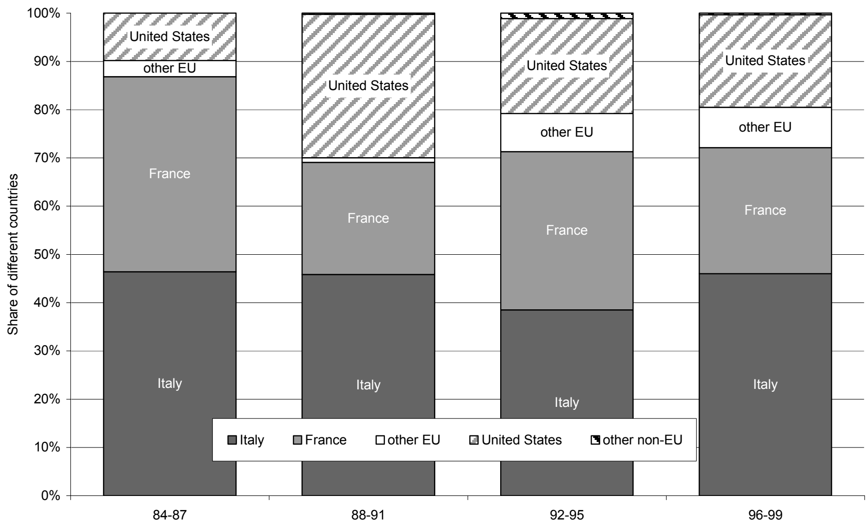
OECD Triadic Patents database, own calculations

Fig. 71. Location of ICT Patent Inventions of Siemens, Priority Years 1984/87, 1988/92, 1993/95, 1996/99



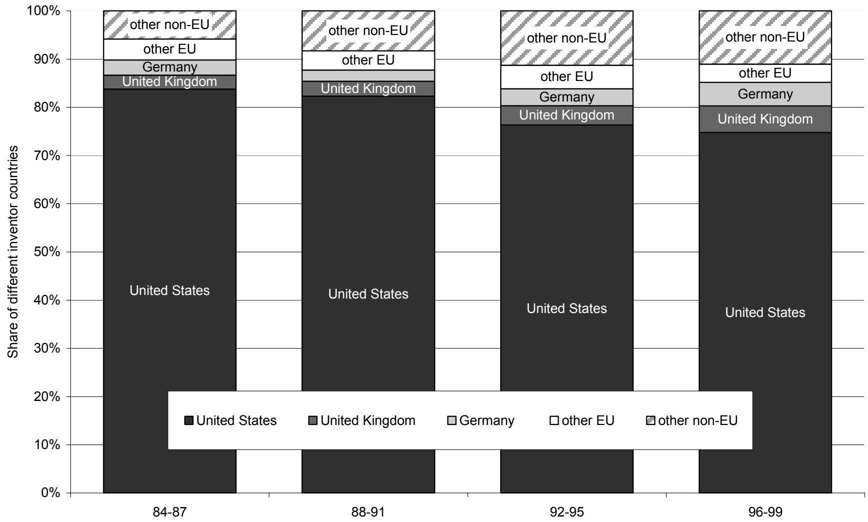
OECD Triadic Patents database, own calculations

Fig. 72. Location of ICT Patent Inventions of Nokia, Priority Years 1984/87, 1988/92, 1993/95, 1996/99



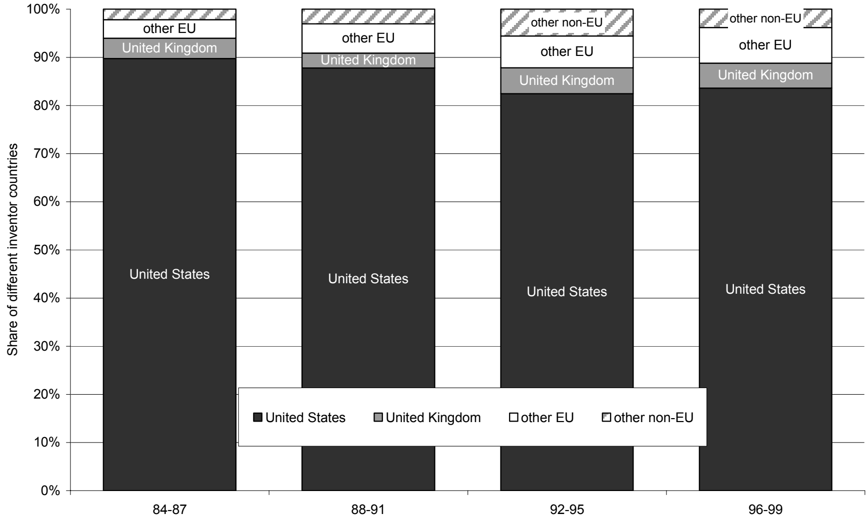
OECD Triadic Patents database, own calculations

Fig. 73. Location of ICT Patent Inventions of STM, Priority Years 1984/87, 1988/92, 1993/95, 1996/99



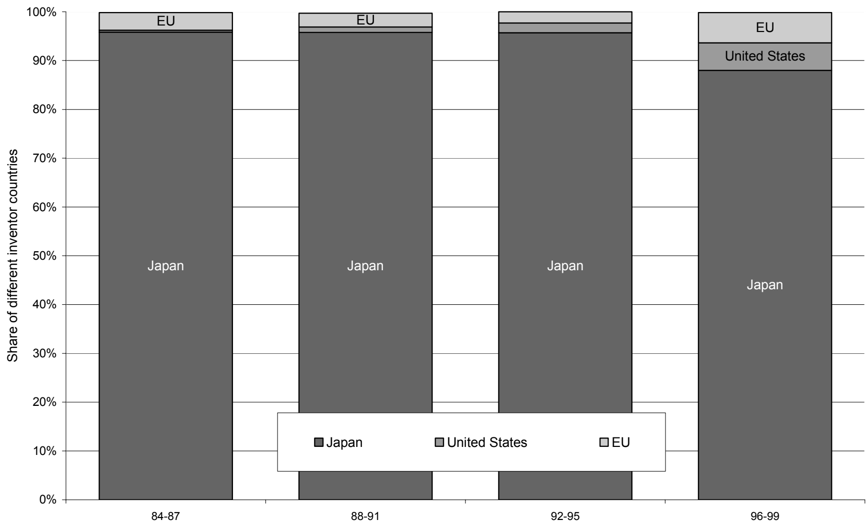
OECD Triadic Patents database, own calculations

Fig. 74. Location of ICT Patent Inventions of IBM, Priority Years 1984/87, 1988/92, 1993/95, 1996/99



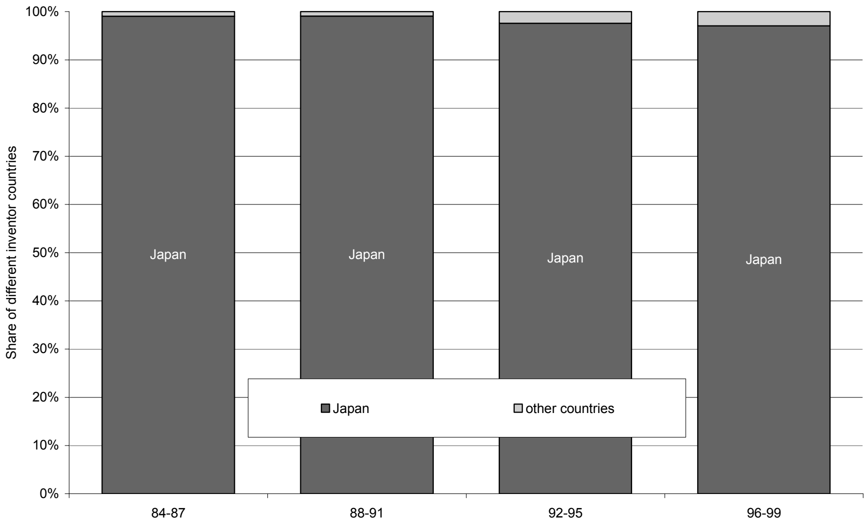
OECD Triadic Patents database, own calculations

Fig. 75. Location of ICT Patent Inventions of Hewlett Packard, Priority Years 1984/87, 1988/92, 1993/95, 1996/99



OECD Triadic Patents database, own calculations

Fig. 76. Location of ICT Patent Inventions of Sony, Priority Years 1984/87, 1988/92, 1993/95, 1996/99



OECD Triadic Patents database, own calculations

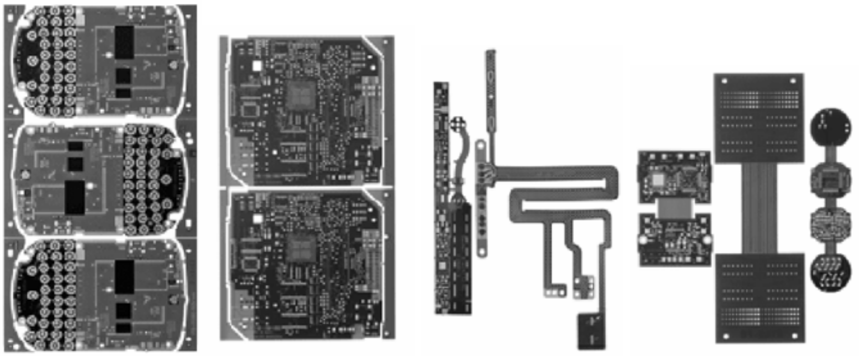
Fig. 77. Location of ICT Patent Inventions of Toshiba, Priority Years 1984/87, 1988/92, 1993/95, 1996/99

Appendix E Case Studies

1 AT&S (Austria Technologie & Systemtechnik, by Bernhard Dachs, ARC)

1.1 Introduction

Austria Technologie & Systemtechnik (AT&S) is an Austrian producer of printed circuit boards (PCB) with production facilities in Europe, Korea, China and India. PCBs are passive electronic components found in all sorts of electronic devices such as: mobile phones, computers, electronic cameras or measurement equipment. PCBs must meet two basic requirements: first, they have to carry and integrate all types of electronic components; and second, they have to be as small and well-adjusted to the device as possible.



Source: AT&S (2006)

Fig. 78. Examples of Printed Circuit Boards

PCBs are mass-produced items and the PCB market is largely dominated by Asian firms. AT&S is the largest – and one of the few remaining - European producers that survived in this segment of the electronics industry. This case study will ask how the company could prevail in this highly competitive environment.

1.2 Description of the Company

AT&S was founded by the Austrian government in 1990 as a holding company of three PCB factories in the Southern provinces of Austria. In 1994, the company was privatized and is listed on the Frankfurt stock market since 1999. Since privatisation, AT&S has been growing steadily. In the business year 2005/06, AT&S generated a turnover of 374.7 Mio. Euro, and had about 4,600 employees. Business Week (2005) has ranked AT&S among 'Europe's 100 Hot Growth Companies' which exhibited the strongest growth in recent years.

Table 39. Key Figures of AT&S

Financial Year	2005/6	2004/5	2003/04	2002/03	2001/02	2000/01
Total revenues (1,000 Euro)	374,698	332,358	316,442	277,505	274,496	322,866
Earnings before interest and taxes (EBIT, 1,000 Euro)	26,342	26,750	28,075	20,251	7,530	53,889
Number of employees (average)	4,663	3,833	3,578	2,920	2,855	2,906

Source: AT&S Annual Reports (various years)

As a producer of electronics components, AT&S is specialized in High Density Interconnection (HDI) Microvia boards. AT&S was one of the world-wide pioneers of the HDI production technology (Leitner, 2003, p. 258). In contrast to other production techniques, HDI allows smaller board layouts which, in return, allows for smaller devices. This makes HDI boards very appealing for portable devices such as PDAs or mobile phones. A close partnership with Nokia was one of the reasons why AT&S was able to establish itself in this market segment. Today, AT&S is the only large European company operating in the PCB market, and mainly a supplier for the telecommunications industry, which accounts for two thirds of AT&S' revenues in 2004/2005.

AT&S benefited from the surge in mobile telecommunications in recent years and established itself as a supplier for Nokia, Siemens, Motorola, Research in Motion (RIMM), Flextronix, etc. PCBs produced by the company are found in about 40% of all mobile phones produced in Europe and nearly 15% of mobile phones produced worldwide. The computer, automobile and instruments industry contribute about one third of AT&S' sales.

Besides production, AT&S is also engaged in PCB design activities for its customers. Design is a major constituent of the PCB business - simply because each device has a different shape and different components and therefore needs its own layout. Moreover, there are a lot of applications where no off-the-shelf PCB is available or not appropriate. Here, customers need a tailor-made product. An example is the design and production of a PCB for the engine control system of the new Airbus A 380 airplane which has been designed and produced by AT&S for a supplier of Airbus.

1.3 International Expansion of AT&S' Activities

International expansion started with the acquisition of India's largest PCB manufacturer in 1999. In the same year, AT&S acquired a PCB factory from Siemens in Augsburg, Germany. This plant was closed in 2001.

The Shanghai plant, a Greenfield investment, was initiated during the mobile industry slump in 2002 and started operation in December 2002. In September 2005, AT&S acquired the Indian company ECAD, a specialist in PCB design services, which enlarges AT&S' design capabilities considerably.

The latest step in AT&S' international expansion was the acquisition of TOFIC Co. Ltd. in February 2006. TOFIC is a Korean manufacturer of PCBs, considerably smaller than AT&S, and has 240 employees. According to AT&S, the move to Korea serves three purposes: First, it expands the company's production capacity in Asia. Second, AT&S buys market shares in Korea and establishes itself as a supplier for the Korean and Japanese telecommunications industry. And third, and maybe the most important effect of the takeover of TOFIC is that AT&S acquires not only a company, but is also entering the market for flexible PCBs. There were already plans at AT&S to begin with the production of this type of PCB. However, the company favoured this type of access compared to building up its own production of flexible PCBs.

AT&S has currently four production locations in Austria (Leoben, Fohnsdsorf, Fehring, Klagenfurt) and one factory each in India (Nanjangud), Korea and China (Shanghai). Smaller sales offices are located around the world. A second facility in Shanghai is currently under construction and will begin operations in 2006. The company is currently investigating the set-up of a second plant in India.

The group today (April 2006) employs about 4,600 people worldwide, about 60% in Austria, some 700 persons in India, and approximately 1,000 in China. Another 240 employees work at the newly acquired company in Korea. The number of employees increased considerably during the last five years for the whole group - as can be seen in Table 39. Although there are no employment figures available at the plant-level, we can conclude from the information provided in the company's annual reports that job increases happened mainly at the Asian locations. Employment gains in Austria are likely be found in headquarter functions, such as central administration, R&D and in product development and marketing units.

1.4 Motives for Internationalisation

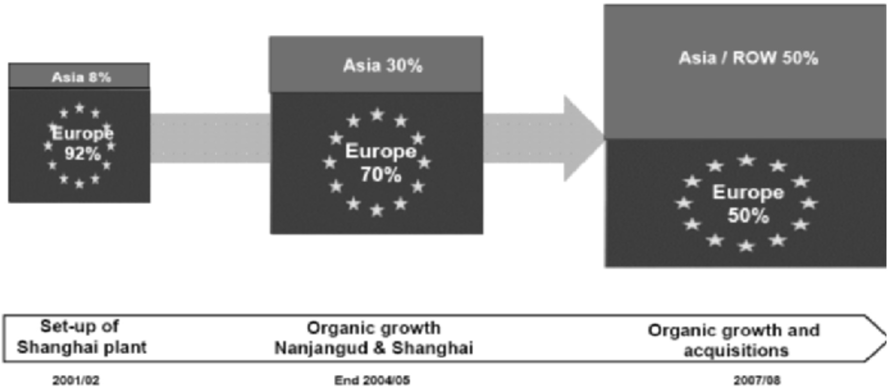
It became clear to AT&S at the end of the 1990s that the company had to expand its operations for abroad for several reasons: First, market growth seemed to be higher in Asia than in any other part of the world. Second, production in Asia could make AT&S less vulnerable to exchange rate fluctuations. Third, production capacities in Austria had reached their limits and had to be expanded. And fourth, production costs in Asia were lower than in Austria.

Looking back, the decision of AT&S to go abroad was motivated by various reasons and therefore cannot be reduced to a single motive. Labour cost differences were certainly an important determinant for going to Asia. According to company representatives, personnel costs account for 30-35% of total cost in the European production, but only for 5-10% at Asian plants. However, even if labour costs were equal between the two locations, there would be some other good reasons to internationalize production. Demand for AT&S' products increases faster in Asia than in other parts of the world, and main customers of the company have started production on this part of the world. The company followed its customers to Asia – which are predominately the large mobile phone producers. Local producers, in contrast, are not important customers of AT&S in Asia.

The expansion to China, India, and, most recently, to Korea, therefore also targets at opening new markets and reflects changes in industry and customer structure. Moreover, AT&S and the whole European ICT industry suffer from the current exchange rate of the Euro against the Dollar and Asian currencies. Production in Asia reduces the vulnerability of the company to exchange rate fluctuations. The acquisition of the Korean company TOFIC adds another motive, the acquisition of foreign technology.

1.5 International Organisation of Production

Only four years ago, production activities of AT&S were located almost entirely in Europe. Since 2001, the share of Asia in the company's total output has been increasing considerably and is expected to increase further in the coming years (Figure 79).



Source: AT&S (2006)

Fig. 79. Geographical Distribution of Production Activities at AT&S

The expansion to Asia, however, will also lead to a new division of labour within the company. In the future, AT&S will concentrate small-lot, niche production, prototyping and tailored design activities in Europe while mass production will move to Asia. An example of such niche products is the aforementioned engine control system PCB. Such PCBs are produced only by the dozen and not by the thousands, and the final price of the component is only a very small fraction of the total production cost of the final good. Therefore, demand is less price-sensitive than for mass-produced PCBs, for mobiles or cameras.

In offering such design services, AT&S tries to capture more steps of the value chain. AT&S provides design capabilities to customers from the electronics, instruments or automotive industry who do not have own design facilities. Large telecommunication manufacturers with their own design facilities for PCBs may benefit from AT&S' wider experience with the underlying technology – as a producer of PCBs – which may enable AT&S to provide more flexible solutions to design problems.

AT&S' experiences in Asia were very positive up to this point. According to the interviewee, the company was surprised how fast a high quality of the manufacture could be achieved in the new factory in Shanghai. A negative experience is the lack of legal protection and the weak legal system in China. Moreover, foreign enterprises in China have to deal with a weak loyalty to the company and a high turnover of employees. The strengths of Europe, in contrast, are flexibility and proximity to the customer.

1.6 R&D and Innovative Activities at AT&S

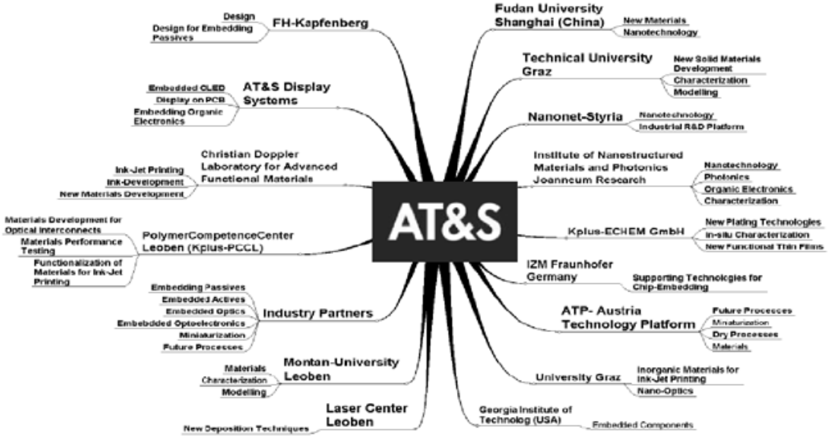
AT&S is engaged in two types of innovative activities: a) customer-specific design of PCBs (described above), and b) research and development for the companies' own technology needs. Custom-specific design activities are internationalized with units located in Germany and India. The Indian branch serves the local market but is also engaged in projects acquired by the Austrian headquarters.

R&D at AT&S is focused on the improvement of current production processes as well as materials with a timeline of 3-5 years ahead of production. Moreover, the company is also engaged in long-term observation of technologies that may lead to technology disruptions. Examples are photonics, nanotechnology, 3-dimensional structuring or optical waveguides. The R&D unit employs about 25 persons.

In contrast to design activities, AT&S' research and development activities are concentrated in Austria. There are minor R&D operations in China, but these only support local production. Despite its international organisation of production, the company's R&D activities are deeply rooted in the Austrian Innovation System, as can be seen from AT&S' co-operation network (Figure 80).

This coincidence of international fragmentation in production and concentration on the home country in R&D is a well-known result from empirical studies (Patel and Pavitt 1999; Narula, 2003). It reflects the fact that corporate competencies are the results of complex, path-dependent cumulative processes and an intensive exchange between the company and its environment.

Ties in R&D exist between AT&S and local Styrian universities (Technical University Graz, University Graz, Montanuniversität Leoben, FH Kapfenberg) - with contract research organisations (Joanneum), federal-funded research initiatives (K-plus ECHEM, K-plus PCCL), and industrial partners. Aside from these local ties, AT&S is also co-operating with international partners, including the German Fraunhofer-Gesellschaft, a US and a Chinese university. These international co-operations, however, are not closed between a local affiliate of the company and the partner institute, but with the headquarters in Austria. The acquisition of new technology was not a motive of AT&S' internationalisation until recently.



Source: AT&S (2006)

Fig. 80. Research and Development Co-operations of AT&S

1.7 Summary

The case of AT&S shows that European producers can stay competitive even in mass-production fields like the PCB market dominated by Asian enterprises. To achieve this goal, however, AT&S had to purse a strategy consisting of three parts:

- specialize on a specific segment of the PCB market (e.g. HDI microvia boards for the telecommunications industry).
- take advantage of lower production cost and proximity to customers in Asia.
- focus activities in Europe on more custom-specific, tailor-made products - which exhibit a lower price elasticity.

The expansion to Asia followed two motives: The first one was market-driven. AT&S saw that its clients were turning their attention to the Chinese market. The company followed their customers, the large mobile phone producers, to Asia. A second goal was to benefit from cost advantages.

In the long run, AT&S' strategy is to locate mass production in Asia, while knowledge-intensive activities, the production of less price-sensitive products and company design services remain in Europe.

1.8 References

The case study is based on personal Communication with René Berger, Director Communications, AT&S. Moreover, the following literature was used:

AT&S (2006) AT&S Company Presentation. Vienna. http://www.ats.net/inforum/filedb/857b964aaa22c3adefdcfa87660c961b.pdf
AT&S (various years) Annual Report. http://www.ats.net/en/index.php?content=667
BARBA NAVARETTI G, VENABLES AJ (EDS) (2004) Multinational Firms in the World Economy. Princeton University Press, Princeton and Oxford
BUSINESS WEEK (2005) Europe's Hot Growth Companies Business Week
LEITNER K-H (2003) Von der Idee zum Markt: Die 50 besten Innovationen Österreichs. Böhlau, Wien
NARULA R (2003) Innovation Systems and 'Inertia' in R&D Location: Norwegian Firms and the Role of Systemic Lock-in. In: Narula R (ed) Globalisation and Technology: Interdependence, Innovation Systems and Industrial Policy. Polity Press, Cambridge, 76-106
PATEL P, PAVITT K (1999) Global Corporations and National Systems of Innovation: Who Dominates Whom? In: Archibugi D, Howells J, Michie J (eds) Innovation Policy in a Global Economy. Cambridge University Press, Cambridge, 94-119

2 OCÉ N.V. (by René Wintjes, UNU-MERIT, Maastricht)

2.1 Introduction

Océ operates in the science-based industry of copiers and printers that is dominated by Japanese and American companies. Océ is specialized in the higher value market segments of wide-format and large volume machines. Out of the 24,000 employees worldwide, approximately 4,000 work in The Netherlands. Headquarters are located in Venlo (the Netherlands), as is a large part of the assembly and most of the R&D. Total R&D manpower is about 1900, approximately 500 of which are in software development. Océ was founded in 1877 in Venlo, taking its first steps in the copying business in 1920.

In this case study we focus on the following global trends as witnessed in the respective transformations of Océ and it’s business namely, digitisation, globalisation, and the rise of the service-economy. With its first self-developed printers in 1986 and the introduction of its first fully digital copier/printers in 1994, Océ joined the Information Technology (IT) sector. Océ now supplies a wide range of products and services for copying, printing and more recently, for digital document management. Within a relatively short period of time, digitisation played a decisive role in all levels of the organisation. For example, currently software has become the major discipline in Océ’s research and development. The statistics indicate that Océ is probably still listed under manufacturing industries as a producer of office machines, but since employment in manufacturing & logistics represents only 10% of total employees ijn 2005 (against 22% in 1997), Océ is rapidly entering the service economy. Before we look back to Océ’s early steps in internationalisation and discuss the recent shift to global sourcing and the first experiences of assembly abroad, we provide a brief up-to date profile of the company

2.2 Description of the Company

Océ is one of the world's leading suppliers of professional printing and document management systems. The company develops and manufactures systems for the production, distribution, and management of documents, in both colour and black and white and in both small format and wide format, to offices, industry and the graphics market. This relates to printers, scanners, peripheral equipment and printing media but also to document management software and innovative products in the areas of system integration, outsourcing of document management activities, and leasing of machines.

Océ is commercially active in 80 countries and has its own sales and service establishments in over 30 countries. It also operates research and manufacturing facilities in various locations in Europe and the United States. In 2005, Océ, which employs more than 24,000 people, achieved revenues of € 2.7 billion and a net income of € 79 million.

	2005	**2004**	**2003**	**2002**	**2001**
Total revenues (€ million)	2.677	2.652	2.769	3.176	3.234
R&D expenditure as % of total revenues	7,2 %	7,8 %	7,7 %	6,8 %	6,3 %
Operating income as % of total revenues	4,1 %	4,2 %	4,5 %	7,1 %	6,9 %
Payroll expenses as % of total revenues	44,2 %	46,3 %	45,9 %	42,4 %	40,5 %
Number of employees	24.164	21.315	22.204	22.489	22.472

Source: Océ N.V. Annual Report 2005

Océ's business model is based on close cooperation between sales and services and research & development. Thanks to the constant feedback of experience gained from ongoing intensive contact with users, Océ is able to respond promptly to changing market requirements. As Mr. Lambregts explained: "This very moment, most employees of Océ are visiting clients". The company's own sales and service organization has attuned its activities as accurately as possible to the market segments that are of strategic relevance. In a number of countries part of the product range is made available via specialised distributors. Océ develops its basic technologies and most of its product concepts in its own R&D facilities of which the one in Venlo is still by far the largest. In all cases the R&D involves searching for ways of providing specific solutions for each customer's current and future needs. The desire to develop totally new concepts to meet these needs is the source of the company's technology base. Océ's innovative capabilities are also enhanced and maintained through alliances with strategic partners and through cooperation with co-developers and suppliers for machines in the high, medium and low volume segments.

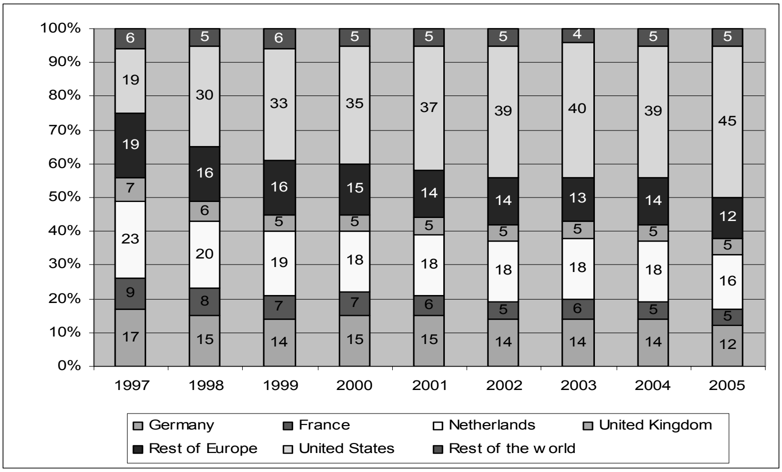
2.3 History of Step-Wise Internationalisation

Before the 2nd World War, internationalisation mainly involved licencees. After the American licensee was established (which gave the right to sell the special paper for copying), a German and a British licensee were found in 1928, followed by a Swiss licensee the following year. Norway, Belgium, Sweden, Denmark, Finland, Italy and France soon followed and beyond Europe, both Mexico and Argentina. In 1933 trips to the Far East resulted in agreements with China, Hong Kong, India and Japan.

In 1958 after a dispute with their first licencee Bruning (the US licencee), the comany drastically adopted a new internationalisation strategy. Océ no longer , a strategy that gave them more control over the foreign activities and increased their involvement and direct contact with the clients. The network of retailers and licensees was replaced by its own foreign branches. The first of these was opened in Germany in 1959, one year after Océ floated on the stock exchange. A series of mergers and takeovers followed. In 1964, the company took over the activities of the Belgian Jobé. Take-overs of companies in Sweden, Austria, Denmark, Norway, Italy and France followed. The first branch in the United States was established in 1970 as the result of the take-over of Elliot in Pittsburgh, which was at the time a licencee. During the 1970s, Océ also set up branches in South America and in Australia. In 1991 Océ took over Bruning, their first licencee. Special mention must be made in Océ's story of expansion of the 1978 take-over of its biggest competitor, the British Ozalid Group, which had branches in some fifteen countries. Ozalid's dry diazo process also gave Océ access to the major users in drawing offices. Another special event was the take-over in 1996 of the High Performance Printer Division of Siemens Nixdorf, with its head office in the German town of Poing. The latest acquisition occurred in 2006, with Océ's takeover of Imagistics International Inc., a direct sales and services provider of document imaging solutions which serves the USA, U.K., and Canada, and is headquartered in Trumbull, Connecticut, USA.

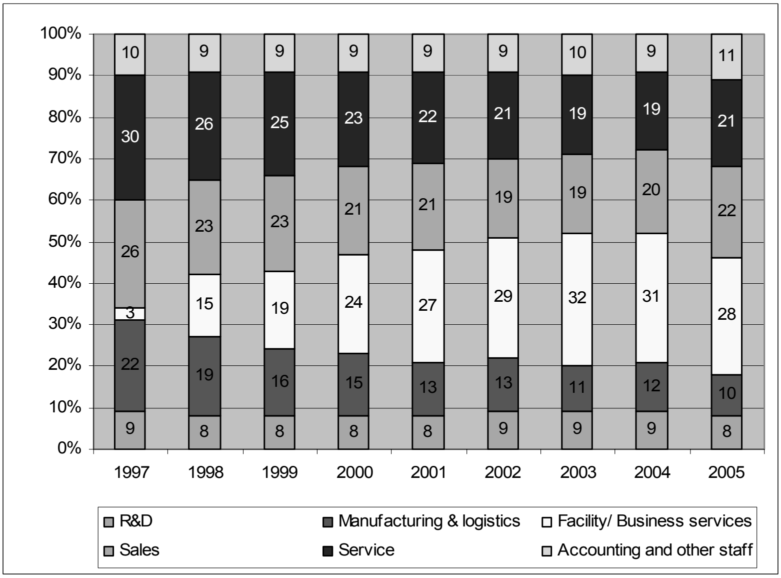
Between 1997 and 2005 the share of total employees working in the Netherlands has decreased from 23 to 16 percent (see figure 81), but since the total labour-force has increased, the absolute number of jobs in the Netherlands has remained fairly stable at about 4,000 employees. Growth in the number of people employed by Océ is concentrated in the United States.

The shift in the distribution of employees by type of function has been very dynamic (see figure 82). Employment in business services has been especially increasing. The number of employees engaged in manufacturing & logistics has decreased from 4,000 (22%) in 1997, to 2,500 (12% of total) in 2004, and 10% in 2005. A slow decrease in the share of employment in service and maintenance was stopped in 2004 and slightly increased again in 2005. Because of the high revenue margins on service and maintenance contracts, some stock-market analysts were happy to see that the recent effort to win more service-contracts started to pay off.



Source: Océ annual reports

Fig. 81. Distribution of Employees by Geographical Area's, Percentage of Total Employment, 1997-2005



Source: Océ Annual reports

Fig. 82. Distribution of Employees by Type of Work, Percentage of Total Employment, 1997-2005

2.4 Inter-Disciplinary R&D Core Remained Concentrated in Venlo

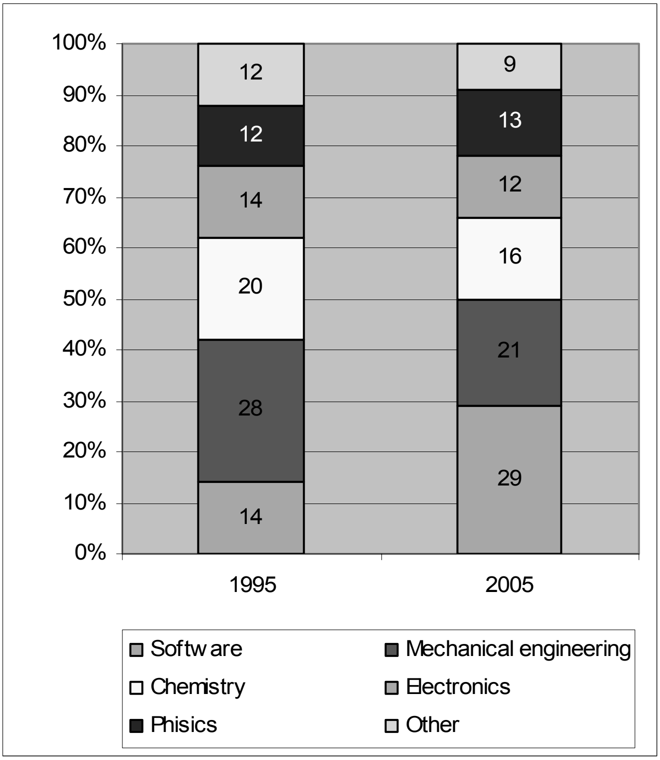
Currently, Océ's R&D activities are located in seven countries. The facilities in Venlo with almost 1100 of the total 1900 R&D personnel, focus on the development of cut-sheet and wide format printers and scanners, strategic materials (toners and photoconductors) and software. In Poing (Germany) the R&D activities focus on the development of high volume printers and software. In Vancouver (Canada) the R&D facilities are specialised in display graphics wide format colour printers, and Fiskeville (USA) is the home of the R&D department of Arkwright, which develops specialized imaging media. R&D centres for software development are located in Créteil (France), Namur (Belgium), Konstanz (Germany), Timisoara (Romania), Salt Lake City and Phoenix (United States).

Except for Timisoara, the R&D activities abroad are consequences of takeovers, so the location of these foreign R&D activities is not really the result of explicit location-decisions. The recent small unit in Romania has been set-up directly by the French subsidiary of Océ in Créteil who have 'near-shored' some of their software development activities to Timisoara because of the lower labour-costs in Romania.

There are two different ways in which digitization has become increasingly important for Océ: (i) the internal software in the copiers and printers and, (ii) the external software that links the machines to networks that manage the workflow to and from the machines. This last part of digital document management is a growing business for Océ.

Océ's multi- and inter-disciplinary nature of the research and design activities is characteristic of Océ's R&D. The developers operate in centrally managed project groups in which all relevant disciplines are represented. In this way Océ can harness all of the know-how, experience and skills available within the business to innovate its range of offerings. In 2004, Océ spent € 207 million on R&D. This is equivalent to 7.8% of its revenues. Figure 6 shows the rise of importance of software as being one of the R&D disciplines of the core R&D unit in Venlo between 1995 and 2005. Both the increased importance of IT and software as well as this multi-disciplinarity is witnessed by the distribution of disciplines of the R&D personnel at the site in Venlo. IT and software has become the most important R&D discipline, however, the other disciplines of chemical, electronics, mechanical and physics remain important as well. Due to the complexity of the machines in which many technological disciplines interact, it is essential to have people from different disciplines cooperate in proximity. As Mr. Lambregts (Vice President, Engineering) explains the 'one room' concept: *"It is very difficult to physically split the activities and disciplines on a certain R&D project. Even within this building they want to be together in the same room and when the team grows they actually want to make holes in the walls in order to ease communications."* Therefore it has been difficult to globalize Océ's R&D located in Venlo. However, part of this 'one room' concept has recently been simulated digitally, e.g. at the end phase of engineering when the team in Venlo and co-developers in the Far East work on the same CAD design.

The part of the R&D activities that have globalised, relates to the outsourcing of the production of parts and modules that has been taking place since the 1970s. Back then, Océ decided to outsource production, while assembly was to remain in Venlo. The latest development is that some engeneering will be done in the Far East. In particular, engineering related to the after-care (when during the production of parts, there is need for some minor adjustments), which is now considered better to do a large part of that work in Asia where it is close to the supply chain.

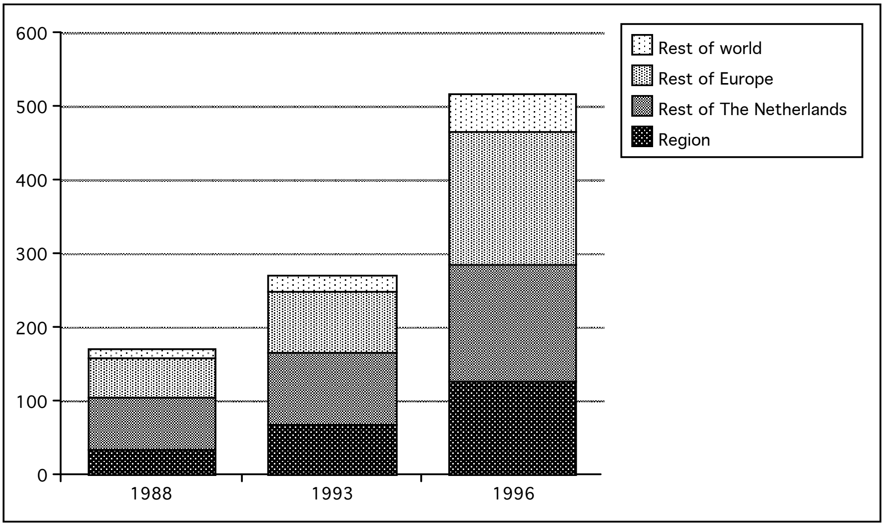


Source: Océ

Fig. 83. R&D Employees by Discipline, % of Total R&D in Venlo in 1995, 2005

2.5 Globalising Production: From Outsourcing to Regional Suppliers, Towards Global Sourcing and Increased Near- and Off-shore Assembly

During the 1990s the total amount of purchasing increased a great deal. Regional and other Dutch suppliers had also managed to increase their supplies to Océ (see figure 84). However, the share of purchasing originating from Dutch suppliers, has been decreasing throughout the 1990s, the trend of which has been relevant ever

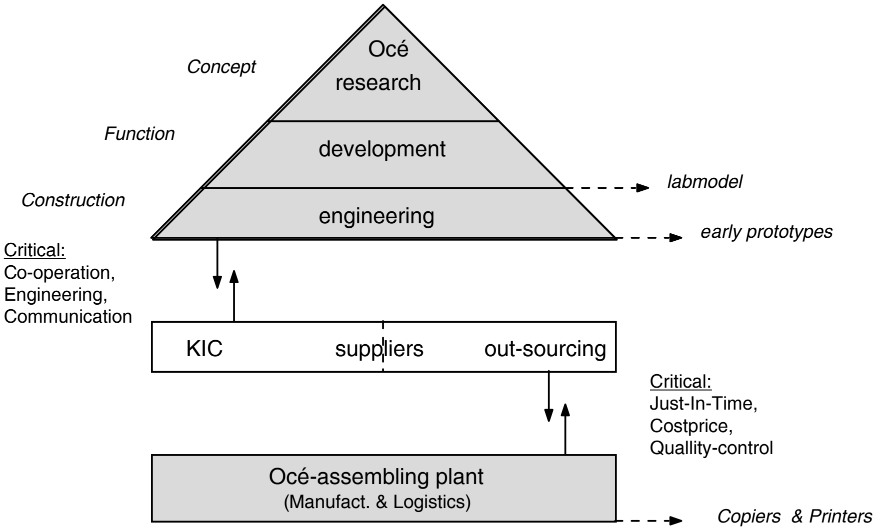


Source: Wintjes and Cobbenhagen (2000)

Fig. 84. Origin of Océ's Purchasing, Geographical Distribution, in mln. NGL for 1988, 1993, 1996

since. In the latest annual report, Océ announced the goal to increase the share of purchasing from Asia up to 50 percent.

A regional innovative cluster policy project of that period helped to transform regional SME 'jobbers' into innovative networks of co-developers of modules. In 1993, Océ initiated the KIC project (Knowledge Intensive industry Clustering) in order to involve suppliers in the product development process with the help of public policy support (see Rutten & Boekema, 2004 and 2005; Derix, 1998). The concept revolved around the idea that engineering of new parts and modules could be outsourced to suppliers in the region who had up-graded from "jobbers" to "co-developer," or even "main supplier." Technically speaking, (that is in the eyes of the R&D department), most of these clusters have been successful; however the purchasing department has been less enthusiastic. In figure 8, the vision on the position of these Knowledge Intensive Clusters (KIC) is placed closer to 'engineering', while out-sourcing is positioned as traditional purchasing where price, just-in-time, and quality control are the basic criteria (on the right). Many of these micro-clusters of regional suppliers that had made good prototypes did not get the actual contracts to produce larger batches, because production abroad appeared to be less expensive. Some of these regional suppliers still have Océ as one of their clients, and most of them have invested in manufacturing facilities in Central and Eastern Europe to reduce production costs. The main trend though, is that partners in Asia, e.g. Singapore and Malaysia, have become important innovative suppliers. In 2005, about 20-30% of all the parts and components originated from Asian Suppliers, and Océ has recently announced that in order to reduce costs, 50 percent of the supplies for the assembly in Venlo must come from Asia. While this will not have a dramatic impact on the number of jobs at Océ, it might mean that some European suppliers may not get new assignments from Océ.



Source: Wintjes and Cobbenhagen (2000)

Fig. 85. Schematic Vision in the 1990's About the Position of Regional Knowledge Intensive Cluster of Suppliers in between Océ's R&D-Unit and Assembly Plant

In 2000, it was expected that the strong growth in demand could be handled by a smaller workforce by sourcing at an increasingly higher level of aggregation (complete units), transferring part of the assembly operations to Pardubice (CzechRepublic), and by substantially boosting productivity. A new assembly hall was opened in Pardubice, which also produced modules for the Océ400. At the beginning of 2001 the assembly facilities in Guérande (France) were sold to Manufacturing Services Ltd.. They continued to produce for Océ on a contract basis, and remained as one of Océ's biggest supplier of scanners, folders and integrated circuit boards.

During 2004, the relocation of part of the assembly and manufacturing operations to Central Europe and the Far East was initiated, resulting in the discontinuation of 175 jobs at the manufacturing facilities in Venlo. Outsourcing has increased even further, however, it should be noted that manufacturing has never been Océ's core competence and for many years, approximately 95 % of all parts were being manufactured by partners.

The greater proportion of the printers in the Océ range originate from the company's own manufacturing facilities located in Venlo, Poing [Germany] and Prague/Pardubice [Czech Republic]. However, by far the greater proportion of the components and modules incorporated in the machines that are assembled there, have for many years, been manufactured externally by a select group of suppliers. Since 2004, Océ machines and modules have also been produced in Asia by third parties on the basis of contract manufacturing. These are supplied direct from Asia to the Océ sales companies. The increasingly larger input of suppliers and contract manufacturing partners in the production process, is taking place in parallel with the company wide change process that has transformed Océ from a hardware supplier into a supplier of complete printing solutions. Nevertheless, manufacturing and final assembly still maintain their place within Océ, between R&D and the sales and service organisation, in a single coherent process. The good linkage and cooperation that exists between R&D, manufacturing and service is essential for a smooth and efficient production start up, and for the product improvements that are made over the course of time within each product family. Océ manufactures some of its machines and modules in Asia. The main reason for this is the lower level of wage costs, which enables a substantial reduction in the costs of assembly and components production. This considerably strengthens the company's competitive position. For its production in Asia, Océ uses contract manufacturers and the expertise and networks that they have to offer. The manufacturing and sourcing of a large proportion of required components also takes place in Asia. According to Mr. Rijnsaardt, "The quality is good and the cost price is substantially lower, despite higher logistics costs".

The possibilities for sourcing in CEE, e.g. close to the new assembly hall in Czech Republic countries, has disappointed Océ while the possibilities and first experiences in Asia have been better than expected. Mr. Rijnsaardt (Purchasing Director, Mechanics) stated that the Czech suppliers are very good in metal plating and parts, however, Asia has a much better supply-base for micro-electronic parts.

Océ is now in the middle of a search and investment phase regarding their supplier-relations in the Far East. As with the regional supply-base, it remains very important to maintain good communication between the suppliers and the R&D unit in Venlo. There is an enormous amount of travelling back and forth, and as such, last year they have set-up the Océ Asia Technology Centre in order to promote and coordinate the communication with the suppliers in Asia. *"To support and speed up the relocation activities an 'Océ Asian Technology Center' was set up in mid-2005. Expertise from Venlo is deployed to facilitate the transfer of know-how and experience to our contract manufacturers"*, Mr. Lambregts explained. Developing their Asian supplier network is a step by step process which starts first with a simple module and then develops into a more complex one. The assembly (contract manufacturing) of a relatively simple printer followed, and now Océ are working on having them produce more complex modules. There are also some good experiences with cooperating digitally in some phases of the engineering process. The Asian engineering unit will also become important regarding adjustments after production has started: adjustments that can better be done close to the supply chain in Asia.

A disadvantage for Océ in its outsourcing strategy, is that they do not need very large volumes. The batches of parts and components are very small compared to the large volumes that most Asian suppliers want and are used to producing.

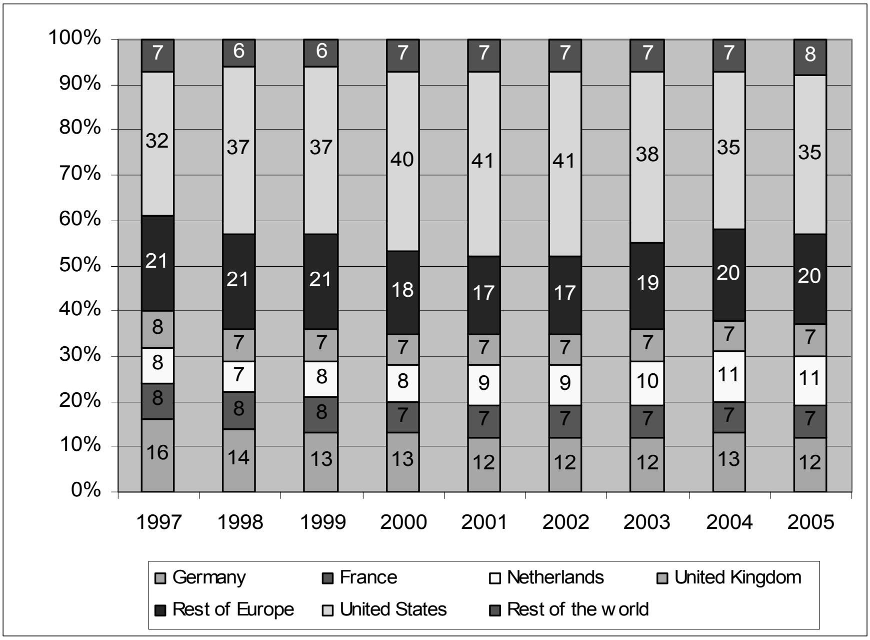
2.6 Where Will Future Developments Bring Us?

As stated in the annual report 2005, the main thrust in the years ahead will be "to convince potential customers that Océ not only has the best but also the most cost-effective offerings. The cost price of our products obviously plays a role in this. That is why it is necessary for us to relocate a large proportion of our manufacturing operations to Asia" .(Océ annual report 2005)

Over the last few years there has been an increasing importance of partners and networking. The latest annual report mentions the following strategy regarding partners:

- The strengthening of product portfolio through co-operation with OEM hardware and software partners;
- Cost savings on purchase of components;
- Co-operation with universities and technology institutes;
- Next steps taken in the relocation of part of assembly activities to Central Europe and via outsourcing to the Far East; and,
- Continued outsourcing of lease activities to strong vendor lease partners.

Where these developments will lead to in the future is not clear. "*We have integrated all design phases, e.g. we do not wait designing a new assembly line before the new product design is fully completed. The problem for us is to decide where it is best to split these integrated phases in development ranging from first product ideas to design of assembly line and actual assembly*", Mr. Lambregts explained. The current contract manufacturers in Asia are not able to design such new assembly-lines - this expertise is still in Venlo. "*Not knowing where it will end, we decided to start and learn from experiences, without making too drastic decisions*". Perhaps, when the Asian market has grown, a need will arise for R&D in Asia so that it is able to meet specific market-demand. In this respect, the US and EU market are more similar to each other. Shifting all assembly to Asia may be hampered by transportation costs.



Source: Océ Annual reports

Fig. 86. Distribution of Revenues by Geographical area's, Percentage of Total Revenues 1997-2005

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3 LogicaCMG CEE (by René Wintjes, UNU-MERIT, Maastricht)

3.1 Introduction

LogicaCMG is a major international force in IT services and wireless telecoms. It provides management and IT consultancy, systems integration and outsourcing services to clients across diverse markets including telecoms, financial services, energy and utilities, industry, distribution and transport, and the public sector. The company employs around 30,000 staff in offices across 36 countries and has more than 40 years of experience in IT services. Headquartered in Europe, LogicaCMG is listed on both the London and Amsterdam stock exchanges. In 1995, Logica opened a branch in Prague. After the merger of Logica with CMG, the merged development activities in Prague lead to the formation of the Prague Product Development Center of LogicaCMG Wireless Networks.

LogicaCMG Central and Eastern Europe (CEE) has grown since 1995 employing more than 600 people (650 end of 2006). They are the market leader in IT services in the Czech Republic and are responsible for the CEE market. Aside from its headquarters in Prague, LogicaCMG CEE has offices in Brno, Plzen and Bratislava (SK), Vienna (At), and Budapest (Hu). They also provide near-shore/offshore services to LogicaCMG clients worldwide. Some of LogicaCMG's software systems for global markets are being developed in the Czech Republic.

In this case study, we focus on the development of the activities of LogicaCMG in Prague and how it is related to their location in the Czech Republic and to their role in the blended model of Global Service Delivary (combining on-site, on-shore, near-shore and off-shore) adopted by the globalised corporate network of LogicaCMG. This case study shows that in the case of globally networked companies, the motives and opportunities for growth ‘abroad’ are dynamic and systemic. This co-evolvement of explanations blurs the boundaries between the originally expected Ownership-, Location- and Internalisation-advantages.

3.2 Description of the Company

LogicaCMG is the result of a merger in 2002 between Logica and CMG, both of which were founded in the 1960s. Although the headquarters are in the UK, the nationality of ownership has become international with offices in 36 countries. Over the past 40 years, the activities have become more international and ‘globalisation’ remains a very relevant trend and strategy.

Milestones

1964 CMG founded

1969 Logica founded, CMG opens first overseas office in The Netherlands

1970 Major project for the European end of a hotel reservation system built in the US by PRC

1972-3 Designed SWIFT network

1983 Voted Company of the Decade by Computing 1983 BCS award for technical achievement for LOGOS speech recognition system 1983 Floated on London Stock Exchange

1991 Advanced Image Processor Terminal, developed for UK MoD for use in Gulf War, wins British Computer Society technical achievement award

Milestones in Czech Republic:

1993 The first project in the Czech Republic. SCADA implementation for Transgas

1995 Czech branch established

1998 Through acquisition of a group of local companies, FCC Folprecht, Logica gained a critical mass and the strongest SAP pool in the Czech market

Billing and mediation contract with RadioMobil (T-Mobile) for CZK 150 million

2001 ISO 9001:2000 and TickIT Issue 5.0 certification

2002 The core system of Czech electricity market implemented in record time of less than four months

2003 Merger completed between Logica and CMG to create LogicaCMG; LogicaCMG Wireless Networks Prague Product Development Centre formed

2004 Successful establishment in management consulting market; New development centre in Brno established

2006 Opening office in Vienna; expansion of Product development branche in Brno

Fig. 87. History and Milestones of LogicaCMG

Total revenues amounted to GBP 1.834 million in 2005. Wireless Networks has revenue of GBP 255 millions, which is 14% of total revenue. LogicaCMG Wireless Networks has produced many innovative products, which have been developed at six Product Development Centres located in the United Kingdom, The Netherlands, Czech Republic, USA, and India.

The company claims to have produced the following ‘world-firsts’:

- First commercial MMS message,
- First commercial videomessage,
- First integrated IP-based total messaging solution for 3G,
- First secure e-commerce transactions over a mobile phone,
- First interactive television show using SMS, and,
- First HTML-based mobile internet gateway for GSM/GPRS.

Fig. 88. Countries with Offices of LogicaCMG

3.3 Motives for Internationalisation and Localisation; Why Czech Republic?

LogicaCMG CEE plays an important role in the so-called 'Blended Delivery Model' which combines on site, on-shore, near-shore and off-shore activity within a corporate network of offices and locations. "In theory, everything is offshore-able, but the extent is limited to the degree with which the client is comfortable". A system of Global Diliveray Services is used to determine where the best places and partners are located to perform an assignment, noting that for some activities that require more interaction and/or intimacy, the clients prefer to be served from a near-shore location rather than an off-shore location.

However, the answer to the question 'why Czech Republic?' had several aspects:

The first reason is that both Logica and CMG had already established offices. Administrative structures were already in place, and they had previous experience from off-shore projects for international clients.

A second reason is based on its central geographic location in Europe, its prospect for EU membership, its relative proximity to other Product Centres in Europe, and its major city, Prague, being an attractive location for qualified staff from other (CEE) countries.

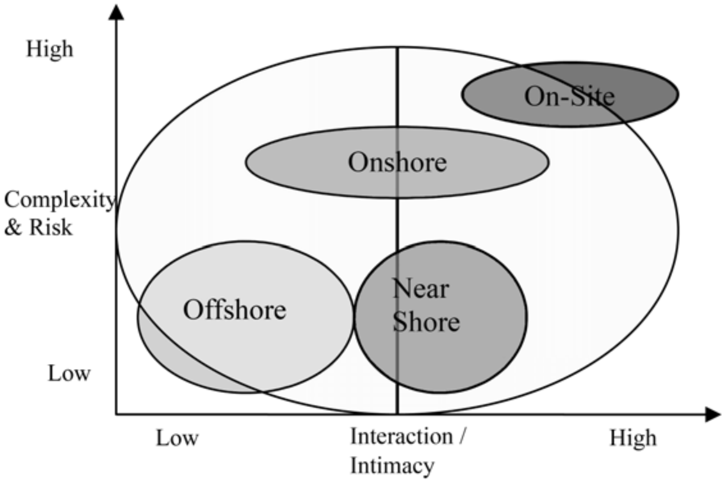


Fig. 89. LogicaCMG's Blended Delivary Model

Furthermore, there were expectations concerning quality, namely, its good educational system, its source of prestigious technologically oriented universities, its access to experienced specialists, its access to an English speaking environment, its stable political environment, its European mentality, and its working environment, all of which were considered to be positive for staff mobility and cooperation. Mr. Turek (Operations Director) explained that another advantage lies in the fact that many of the employees in the Czech Product Development Centre have a career goal of excellent specialist, not manager. This is also the reason why very few people from India have a desire to work here, given their preference to aspire for management opportunities and as such, preference to work in the US. Talent from outside the Czech Republic, originates from Romania, Russia and Ukraine.

A fifth locational advantage that has motivated investments in the Czech Republic relate to costs. Unit costs (per individual) are higher than those in India or elsewhere in the Far East, however, they are significantly lower than in Western Europe. Total costs (per project) are at least comparable with India/Far East or are lower.

Year by year, more of the original expected locational advantages have been confirmed including, among others, growth in Prague and Brno, products taken over and others outsourced, a strong reputation, and good relations with local university centres. According to Mr. Turek, even within ten years, many of the above advantages will still be relevant, e.g. visa-vis India. However, LogicaCMG is not the only company that has a strategy that blends locational advantages globally within a corporate network. For example, recently a company based in India has opened a branch office in Prague with an attempt to sell their off-shore solutions.

3.4 The LogicaCMG Telecom Product CZ Development Centre

LogicaCMG Wireless Networks employs approximately 1,600 employees globally. At the end of 2006, there will be 300 people working at the Czech Telecom Product Development Centre. The other Telecom Product Development Centres are located in Reading and Bristol (UK), Nieuwegein (The Netherlands), Richmond (USA), and Bangalore (India). The R&D core is located in Richmond, while the Telecom Headquarters is located in the UK.

Five years after the first office was opened in Prague, the Product Development Centre was established in 2000. An important element in the decision was a successful pilot project in November 1999. Initially, a great deal of skepticism remained towards the new Czech Product Development Centre, however, this was soon overcome by demonstrated technical expertise. This has been a fast but gradual process of recognition, benefited by the availability of a high quality of human resources at lower cost. Within six months, the centre had grown to include 100 people. The relevant skills and experience are based on the combination of IT & mobile telecomunications technology. In the first period, Prague only received the less complicated tasks however, soon afterward, new functions were added and now the CZ Development Centre plays a role in all phases of the product development cycle. The enhanced reputation implied for instance, that, "They [Richmond] do not have to check our testing results anymore". The full range of activities includes:

- Architecture & Design,
- Development & Verification,
- Product Integration,
- System Sustaining, and
- Business Support.

Product Development is focused on the Mobile Internet, Mobile Messaging and Customer Solutions.

In 2004, an expansion took place in Brno (Cz). The expansion of the Product Development Centre in 2006 will also be concentrated in Brno. At present there are 90 employees at the Brno branch of the Product Centre and it will increase to 150. Allthough it is only two hours from Prague, the costs are lower (approximately 20 % cost savings) and there are approximately 400 – 500 IT graduates per year in Brno.

The responsibilities of the Centre include the development, maintenance and support of LogicaCMG products in the areas of Mobile Internet, Mobile Messaging and Customer Solutions. The product portfolio maintained by the Centre includes products of both strategic importance as well as mature "revenue generators". The clients of the Centre include global mobile operators (e.g. Vodafone, T-Mobile, O2, Orange, J-Phone, Tuka, etc.). They also develop solutions for Huthcinson Whampoa, the operator of the first commercial network of third generation, currently operating in UK, Italy and other countries.

Table 40. World-wide Clients Served by LogicaCMG Telecom Product CZ Development Centr :

Vodafone (UK, Japan, France, Spain, Greece, Germany, NL, Italy, Sweden,…)
O2 (UK, Germany, Ireland, The Netherlands)
T-Mobile (Germany, The Netherlands, USA)
Orange (France, Switzerland, The Netherlands)
Hutchinson 3G (UK, Australia)
Cingular (USA)
Cellular South (USA)
MTS (Russia)
Conecel (Equador)
Telefonica (Mexico, Brazil)
E-plus, ITENOS, RBG (Germany)
AveA (Turkey)
J – Phone, TuKa (Japan)
STC (Saudi Arabia)
TIM (Italy)

In addition to the R&D activities, LogicaCMG also decided to establish a Global Support Centre in Brno during the first half of 2005, for messaging products to provide a centralised support facility for deployment of new messaging solutions, support of daily operations, and for providing maintenance of the installed systems.

3.5 Serving and Entering the Central & East European Market

While the Product Development Centre is specialised and has its product responsibilities in wireless technology, the remainder of LogicaCMG CEE has a market responsibility and offers the whole range of LogicaCMG's sector-specific (related to Energy and utilities, public sector, Telecoms, Industry&trade, and financial services) as well as cross-sector offerings. For any offer, they can involve other LogicaCMG offices and vice versa. CEE offices are involved in offerings of their globally located 'sisters' according to the Blended Delivery Model.

Three years after opening the Czech branch, the acquisition of the local company FCC Folprecht in 1998, was considered an important step in the growth in the Czech market. It was also the year of the first project in Slovakia. The clients are often international companies themselves. From the CEE headquarters in Prague, the CEE market is further developed. Ms. Vavruskova (Marketing Director, Central & Eastern Europe) explained that plans for a new office often start with performing a project. New offices are generally very small for example, the office in Budapest only has three persons. At the beginning of 2006, an office in Vienna was opened, and more expansions will follow, e.g. in Bulgaria. Most growth will probably take place at the locations outside of Prague. The office in Plzen now hosts 50 employees. The growth from 90 to 150 employees that will take place in Brno mainly involves the product development activities. In Bratislava there are 100 employees and the Slovak market has a huge potential for LogicaCMG CEE.

In the Czech Republic, LogicaCMG works for all the major telecoms companies and most of the large financial institutions. It operates the core electricity market system and is generally very strong in utilities. They have a good position in local government and they have one of the biggest SAP consulting pools in manufacturing in the market and are perceived as leading in areas such as security (especially in PKI), CRM and billing, mediation and transaction settlement. The Czech team brings LogicaCMG's global portfolio to local customers, but they also develop local competencies that are used in LogicaCMG's projects world-wide: "Our staff has been involved in projects in many regions, from UK through North America to Asia Pacific".

3.6 Conclusion

Since its establishment in 1995, the Czech staff at LogicaCMG have participated in many LogicaCMG projects world-wide. "We are proud of our reputation for technical excellence, strong discipline and focus on bringing results. We are flexible enough to find the best mode of cooperation with our customers, from time and material support through design and development to full ownership of projects and products."

LogicaCMG's blended model of global service delivery provides an optimum mix of local, nearshore and offshore support. This approach combines the benefits of a single partner with the efficiencies of offshore and nearshore service provision. As part of this blended model, LogicaCMG in Central Europe, provides technological excellence, proven ability to deliver critical solutions on time and budget, and boasts the advantages of regional and cultural closeness to EU clients.

We can conclude that the growth of the activities of LogicaCMG in Prague, Czech Republic, and the CEE market, cannot be seen as a simple shift of production from the west to east of Europe, nor as the result of expansion in new markets. Both the technological capabilities and reputation concerning the development of wireless products, as well as the development of first the Czech and then the other CEE markets, accords with the conceptual framework of internationalisation as a learning process of gradual, stepwise commitment and involvement, and also of accumulated experiences, competencies and reputation.

3.7 Information Sources

Face-to face interview with Mr. Jiri Turek (Operations Director) in Prague on 11th April 2006.

Face-to-face interview with Ms. Eva Vavruskova (Marketing Director, Central & Eastern Europe) in Prague on 11th April 2006.

4 FreeSoft (by Michael Vogelsang, EIIW, Wuppertal)

4.1 Introduction

FreeSoft is the largest Hungarian software company. The Budapest based company offers a full range of software of internet products and services. It relies on international networks, especially with Oracle, but also with other companies. Its internationalisation strategy may be described in short as, **'Develop products, not price competition'**. This especially refers to the strategy of the German and US market to win customers for its database conversion services, convincing them more by a high level of quality and less by differences in labour costs.

Sources of information for this case study have been interviewed with FreeSoft executive, the 2005 annual report, and websites of freesoft.hu and its German subsidiary.

4.2 Description of the Company

4.2.1 History

Founded in 1990, the company's predecessor specialized in developing custom software applications, and by the millennium the small business had grown to be a market leader. After going public in 2004 and by performing acquisitions and restructuring the organization, FreeSoft has become a public corporation with 200 employees and subsidiaries in the United States and Germany.

4.2.2 Products

FreeSoft offers a full range of software and internet products and services. This strategy is in contrast to leading Western European companies, which are mainly specialised in a small range of products (see case study of SAP for example).

Among the activities, the field of software development is dominant. The modernization of traditional IT systems is directly connected to it and is based also on the development activities. These two business branches add to 40 percent of total revenues. Income division in detail:

Table 41. Price Income Division in % of the Freesoft Competence Centers

Document management, office automation	19 %
Introduction of business applications	16 %
Unique developments	33 %
Modernization of traditional IT systems (Legacy modernization)	7 %
Document digitalization, data recording	1 %
Design of Internet applications (design)	4 %
Mobile Internet applications	3 %
COGNOS sale*	14 %
Price revenue of other sales	3 %
Total (= 2.014.370 thousand HUF*)	**100%**

* Business Intelligence Products produced by Canadian company Cognos and sold by Axis Számítástechnikai Kft., a sister-company which was acquired by Freesoft in March 2005
** = approximately 7,6 mil. Euro
Source: Annual consolidated statement of FreeSoft Rt for 2005

4.2.3 Financial Figures

Revenues rose from 803 mil. HUF in 2004 to 2.014 mil. HUF in 2005. However, the numbers are not comparable due to acquisitions of Hungarian companies in 2005.

Therefore only some key figures of the 2005 income statement are presented as follows:

Table 42. Key Figures of the Consolidated Statement of Income of FreeSoft Rt on 31 December 2005 (IFRS); Numbers in Million HUF

Turnover (Sales, Revenue)	2.014*
Costs of goods sold + services transmitted	788
Costs of materials	494
Staff costs	674
Depreciation	57
Profit before taxation	89
Profit after taxation	80

* = approximately 7,6 mil. Euro
Source: Annual consolidated statement of FreeSoft Rt for 2005

4.3 International Expansion

4.3.1 General Strategy

Currently, FreeSoft has approximately 200 employees with subsidaries in Germany and the United States. Research & Development and other central resources are only located in Hungary. The subsidaries are used for sales and marketing only.

Table 43. The Region's Price Revenue Division

European Union (without Hungary)	3 %
USA	4 %
Hungary	93 %
Total (= 2.014.370 thousand HUF*)	**100%**

Source: Annual consolidated statement of FreeSoft Rt for 2005

The main product in international business is the support in migrating databases from old legacy systems to modern databases. In this case, FreeSoft has developed its own software solutions for data conversion, which were used by several government institutions and large companies.

The small number of subsidiaries is offset by the strategic **use of networks and cooperations** with other companies. Pivotal for a range of services, is the cooperation with the US company, Oracle, which supplies database software. International customers are also acquired by direct intermediation of Oracle.

The next step in its internationalisation strategy is to **establish offices in China** and Japan. With China especially, FreeSoft intends to offer software for modern e-government solutions - a market which cannot be served by local Chinese companies due to a lack of competence in this sector.

4.3.2 Outsourcing Offers

FreeSoft offers three lines of products to the German market:

1. NearShore Development: this means the development of individual (custom) software applications. Negotiating, administration and development language is conducted in German. The common intra-EU juridical framework proves to be an advantage. FreeSoft campaigns this 'NearShore Development' as **'Alternative to India'**. However, offering offshoring is no longer part of the strategic scope of FreeSoft (see section above).
2. Migration / Legacy Transformation: migration and conversion of existing data to Oracle Database.
3. Document Management: the document management solution is a web-based database architecture which supports searching and opening of a wide range of archived documents.

In this case, more cannot be added on outsourcing offers, due to the fact that FreeSoft focuses mostly on products and less on price differences. In this sense the development of **unit labour costs is not the main focus** of FreeSoft, whereas the macroeconomic performance in Hungary itself is a crucial factor for its business performance since the volume of governmental orders depends on the national budget directly.

4.4 Annex: Examples of Services Offerered by FreeSoft

FreeSoft offers a full range of software products and internet services. Two examples include:
Document Management Systems, also for Governments

Custom Applications:
Examples:

- a) Museum Registration System (MNYR): Early in 2003, FreeSoft 2003 was selected in a public procurement prOcédure to develop the unified museum registration system at a tender announced by the Ministry of the National Cultural Heritage.
- b) National Health Insurance Fund: The modernization of the Social Security Number (TAJ) registration system: public procurement.
- c) APEH: Development of the nationwide account query system, tax number generation and maintenance system, centralized tax and levy account management system: World Bank tender. And,
- d) Szerencsejáték Rt.: Central tracking and information system of lottery ticket resellers and retail units, implementation of a security policy project, application and systems management.

Office automation:
Audit, Data Security, Application Management (3A):
ERP implementation

Data Entry Center in Bátonyterenye:
Examples:

- a) National Pension Fund: Entering a mosaic index of 400,000 cards;
- b) AB-Aegon Insurance Company: Digitalization and indexing of 500,000 folders;
- c) IT Information Society Kht.: Entering 8,000 data cards; and,
- d) National Pension Fund: Archival of 750,000 floppy disks, in process.

Mobile Solutions
Examples:

- a) Motorola Hungary: wap portal;
- b) Application Development Forum: Content provision and mobile payment solution; and,
- c) Sulinet Online: Distribution management system.

e-Commerce applications
Examples:

- a) Accenture (Andersen Consulting): CeerConstruct.com Central and Eastern European Vertical Marketplace for the Construction Industry;
- b) BitPiac: Closed Marketplace for Telecommunication Products; and,
- c) e-Purchasing solution for local governmental requesting and purchasing systems

Multimedia Training Materials.
Examples:

- a) Matáv Rt.:Preparation for the competition, training materials for internal training;
- b) Saldo Rt.: The New Accountancy Act - 2002, multimedia educational CD-ROM; and,
- c) Windows 95-98 educational tape (as publisher, sold in 1000 copies).

Internet-based database services (using Multi-Portal technology)

- a) Turizmus Kft: Multi-language Internet based program guide for the tourist industry;
- b) Szonda-Ipsos: Online database and portal about party- and politician preferences; and,
- c) Geomédia Kiadó Rt.: Interactive Media and Marketing Database (IRMA).

5 SAP (by Paul Welfens, EIIW, University of Wuppertal[1])

5.1 Introduction

Founded in 1972 in Walldorf, Germany, SAP is a global leader in providing collaborative business solutions to all kinds of firms and all sectors. Five former IBM employees created the SAP GmbH. Their idea was to develop standard application software for real-time business processing. One year later, the first financial accounting software was complete; forming the basis in what later came to be known as the "R/1 system." After a period of rapid growth, SAP GmbH became SAP AG and started on the Frankfurt stock exchange in November 1988. SAP is listed on several exchanges, including the Frankfurt Stock Exchange and the New York Stock Exchange.

SAP R/3 was released in the 1990s. The client-server concept, uniform appearance of graphical interfaces, consistent use of relational databases, and the ability to run on computers from different vendors have been its main characteristics. At the end of the 1990s, the mySAP.com strategy was launched, heralding the beginning of a new direction for the company and its product portfolio. mySAP.com

[1] I am grateful to research support by Jens Perret and Michael Vogelsang, EIIW

links e-commerce solutions to existing ERP applications using state-of-the-art Web technology. Today, based on Enterprise Services Architecture and the underlying integration and application platform, SAP NetWeaver, SAP provides solutions for end-to-end business processes.

Internationalisation of Staff

SAP is the world's largest inter-enterprise software company and the third largest software supplier in the world economy. The most important subsidiary is SAP Americas.

Reflecting its success in business, SAP hired many highly qualified professionals over the course of 2004/2005. The actual number of employees hired exceeded this forecast because of the need to accelerate the development of the new generation of software and because of SAP's high level of success overall. A high share of revenues is coming out of Germany however, the SAP workforce is not representing this. SAP employed 35,873 people worldwide (32,205 in 2004 and 29,610 in 2003) 13,916 of which were located in Germany (13,525 in 2004 and 13,026 in 2003).

The largest increases were in research and development, in which, due to the development of SAP NetWeaver as Business Process Platform, the worldwide employee count rose 18% to 11,629 (2004: 9,882; 2003: 8,854). Service and support accounted for 14,390 employees at the end of 2005 – a growth of 7% (2004: 13,505; 2003: 12,533). Sales and marketing had 6,249 employees (2004: 5,583; 2003: 5,170), representing a rise of 12%. Finance and administration increased by 11% to 3,605 full-time positions (2004: 3,235; 2003: 3,053).

The largest number of employees (61%) works in the EMEA region. Twenty-two percent of employees are in the Americas region, and 17% are in the Asia-Pacific region. The percentage increases were 19% in the Americas, 5% in EMEA, and 27% in Asia-Pacific.

SAP employs people representing 107 nationalities. The Company embraces this diversity as a valuable resource. To maximize the benefit, it adopted a global diversity management initiative involving external advisors and employees from all the regions.

SAP Market Dynamics

SAP has 12 million users, 100,600 installations and 1,500 partners. Its leading software package, SAP-All-in-One, has been sold in more than 50 countries and is used by 7,000 clients. SAP Business One is offered in 37 different country-specific versions and used by more than 9000 customers. SAP is the world's industry leader in the field of IT solutions for small and medium-sized firms: in 2005, 30% of order inflow originated from SMEs, by 2010 a share of 40-45% was expected.

SAP has more than three decades of experience in modern IT service and software development: it delivers mySAP Business Suite as a key program which is considered to be a powerful family of business solutions. SAP solutions are open and flexible, supporting dababases, applications, operating systems and hardware from major vendors. SAP Business Suite creates digital opportunities for raising efficiency and innovativeness along the value-added chain in many sectors and in government.

As software can be applied, the better and the more standardized the building blocs in the value-added chain are, and the better the production process is geared toward flexible adjustment and learning, the increasing use of software in enterprises, including SMEs, stimulates productivity growth. Since SAP offers international solutions for multinational firms of both small and large size, the SAP software product family stimulates the internationalisation process. Through the facilitation of networking, even small firms are able to enter international markets, and the creation of powerful e-commerce platforms helps firms enter into new markets cutting transaction costs. Raising supply chain efficiency, creating stronger customer relationship, and supporting internationalisation of business as well as enhancing innovativeness, are all elements which are vital for SAP. However, most firms need considerable training as a one-off start-up investment for optimally using SAP, since many processes in firms are ideosyncratic and require specific adjustment programming on the side of SAP and its partners.

With regard to enterprise software, there are many small competitors and several medium-sized competitors of SAP. The SAP company offers firms switching to SAP solutions. special migration services, therefore customers using PeopleSoft or JD Edwards IT solutions, can rather easily migrate to SAP.

SAP Custom Development offers a broad range of IT services including:

- SAP Custom Development Projects,
- SAP Custom Development Strategic Planning,
- SAP Custom Develoment Project Management,
- SAP Custom Development Quality Assurance,
- SAP Custom Development Risk Assessment,
- SAP Custom Development Maintenance, and
- SAP Modification Clearing.

Intelligent software allows the user to flexibly combine all elements of the value-added chain and in particular to enhance flexibility and quality while exploiting opportunities for national and international outsourcing.

The main rival of SAP is Oracle which has acquired PeopleSoft and J.D. Edwards. Analysts (Sal Oppenheim, 2005) expect that SAP could generate about 0.5 bill. in additional revenue by winning over Peoplesoft customers in the next few years. With the new product mySAP ERP available since spring 2005, SAP offers new options for customers to modernize IT, and SAP is expected to grow specifically in the US. Since US economic growth is higher than in Germany and the EU respectively, it is natural to expect the share of sales in the US to increase.

5.2 International Expansion of SAP Activities

As of 2005, SAP had approximately 32,000 customers in over 120 countries and employed more than 35,000 people at sales and development locations in more than 50 countries in the Europe, Middle East, Africa (EMEA), Americas, and

Asia-Pacific regions. Thuse, SAP is active in Europe (plus Africa), North-America and Asia, where in all three continents, software development activities exist. Sales in Africa and Latin America and Australia are also noteworthy. SAP does not outsource any of its core functions; only certain services concerning marketing (design, layout, etc.), maintenance and repair of technical equipment or cleaning, are outsourced to external agencies; off-shoring (that is involving SAP labs abroad) is a normal element of SAP internationalisation strategy.

SAP is active in international markets and is also an important foreign investor in the industry. SAP's internationalisation has gone through four stages:

1. Exports of IT services and services (late 1970s and 1980s);
2. Internationalisation of the company through internationalisation of the staff (getting momentum in the 1980s);
3. Setting up sales organizations abroad (in late 1980s and 1990s); and,
4. Creating SAP labs – offshoring software development – in the US and India in the 1990s, followed by similar activities in Shanghai at the beginning of the 21st century.

In the mid-1980s, SAP founded its first sales organization outside of Germany in Austria. Later on, subsidiaries in Denmark, Sweden, Italy, and the United States followed. SAP software is tailored to country-specific needs and industry-specific requirements. There are over 25 industry-specific business solutions, and more than 29,800 customers in 120 countries that use SAP products. Total revenues by region in 2004 were 24 % in Germany, 33 % in Europe (excluding Germany), Africa, Middle East, 11 % in Asia (including Japan), 25% in USA, and 7% in other American regions. SAPs management sees future growth predominately in the Asian market.

The local offices merely serve as sales offices, which are selling SAP solutions and providing services (consulting, etc.) to the local customers, and are acquiring new business partners. Any FDI has the goal to support SAPs exports to that country.

R&D Internationalisation

Exceptions include the Research centers and the Labs which are spread out all over the world. There are 4 European R&D Centers, located in Walldorf, Karlsruhe, Dresden, and Sophia Antipolis (France). Soon, there will be 2 other centers in Belfast and Darmstadt and a new center in Sofia is rapidly expanding. Outside of Europe, SAP has Research centers in Palo Alto, Montréal, Pretoria, and Brisbane.

Of the employees working in R&D, 56% (2004: 62%; 2003: 68%) were employed in Germany in 2005, 20% (2004: 15%; 2003: 9%) are in the high-growth SAP development centers in China and India, and 24% (2004: 23%; 2003: 23%) are in SAP's other development locations.

As a global company, it is not feasible, efficient, or economically viable to conduct all activities in all countries or to develop software in only one location. As such, it makes sense to consolidate certain activities regionally in a cost-effective location and to distribute work intelligently according to talent, cost, and market needs.

SAP is located in many leading high-tech locations around the world. Currently, SAP has 10 development centers in Germany (Walldorf and satellites), Sophia Antipolis (France), Bangalore (India), Ra'anana (Israel), Shanghai (China), Tokyo (Japan), Budapest (Hungary), Sofia (Bulgaria), Montréal (Canada), and the United States (Palo Alto and satellites).

Research activities are particularly supported at the Hasso Plattner Institute in Potsdam and at Paloa Alto (California), partly in cooperation with Stanford University. Key activities are also located in Bangalore, India and Shanghai, China which are crucial for SAP overall dynamics and for expansion in Asia in particular. In the 1970s and 1980s, SAP was mainly active in Europe, however, in the 1990s, SAP created both a lab in the US (Palo Alto) and in India. This testifies to the internationalisation of the SAP Company.

As customers of SAP enter foreign markets or embark upon international cooperation or become active as foreign investors, SAP supports the internationalisation process. With SAP already active in Europe, Asia and North America (and Latin America), the company is well positioned to enhance the internationalisation of modern industry and services. In relatively new fields for software-based modernization, e.g. health care or public administration, the company offers powerful software packages which are tailored to individual customer needs. SAP has not been equally successful in all sectors (e.g. in the 1990s, SAP had some problems in the retail sector in the US), however, the company stands for sustained growth and profitability as well as high reputation among analysts and customers.

SAP is a company with three main geographical centers, namely Europe, the US and Asia, all of which are shaped by internal competition. An important element of SAP's strategy is to emphasize:

- Competition of ideas and concepts so that the firm tries to hire highly-skilled personnel.
- Competition in IT services and software development means global competition. In 2005 SAP generated about 80% of its revenues of € 8.5 bill. in international markets. A serious dispute about establishing a worker's council in 2005 emerged at its home base in Walldorf; while the overall majority was against this, the minority of employees, using certain legal provisions, brought the case to the court and the management finally agreed in spring 2006 to establish a workers' council (Wirtschaftswoche, 2006).
- Competition within the company which creates a particularly strong competition between Walldorf, Palo Alto and Bangalore. As the US growth is higher than in Germany and since the US is the world's leading innovator in ICT, and has institutions and factor market rules facilitating expansion of IT firms (e.g. eager to use flexible working hours which in Germany might face restrictions through trade unions and legislation), SAP could increasingly become more a US-type company; one should not rule out that with accelerated offshoring to the US and a rising role of US managers and stock owners, SAP might finally shift its headquarter to the US.

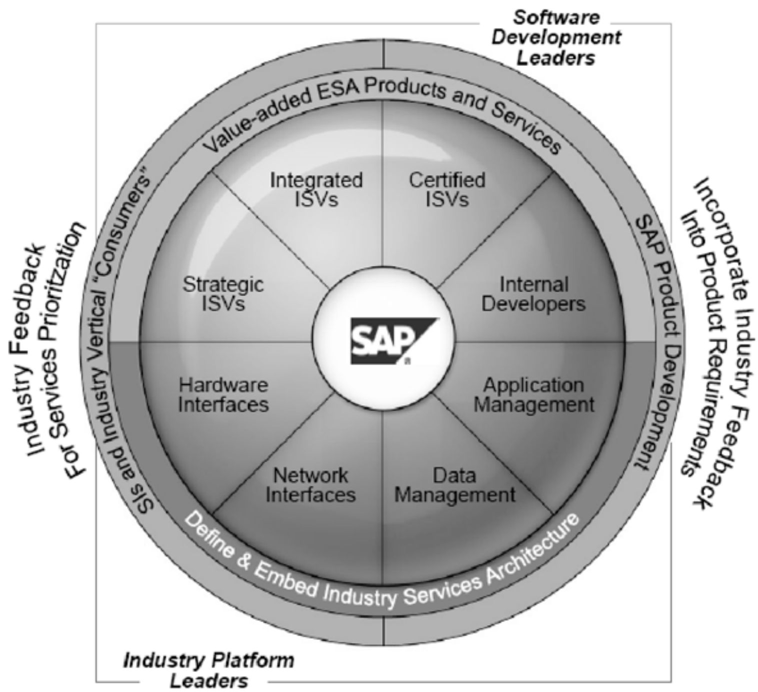
In the period 2005-2010, SAP might transitorily reinforce its European character given that eastern enlargement of the EU has created new business opportunities in Eastern Europe. However, the expansion dynamics in the EU are modest compared to the US and Asia.

SAP outsources work to third parties where it makes sense and in some cases, it is a business requirement to do so. Offshoring is gaining importance with the opening of Europe in regard to cheap labour resources, and also as it centralizes certain core processes (e.g. travel expenses, HR services can be done for a whole region out of one location at a cheaper cost).

SAP is the largest independent software developer (after Microsoft & Oracle). SAP has labs all over the world and tries to partner with other companies where SAP does not have a core competency or main focus. Co-innovation with partners and customers is part of the growth strategy. SAP has a unique partner ecosystem with more than 1,500 partners worldwide and overall more than 180,000 SAP partner certificates.

SAP Ecosystem Charter:

- Drive a sustainable, scalable Independent Software Vendor ecosystem;
- Foster third party development strategic to the business process platform;
- Broaden reach to developer community; and,
- Assume a leadership position in driving enterprise services architecture for the industry.



SAP Ecosystem Framework

The SAP Ecosystems are bringing together partners and customers from diverse industries to share ideas for and innovations in enterprise services, which provide the common business language that enables disparate software applications and infrastructure products to communicate. Because customers, partners and SAP are driving the standardization of enterprise services, they enable more plug-and-play between solutions built along the lines of those definitions, significantly reducing the cost of integration. These services enable companies to compose business processes that reach across IT systems and company boundaries within an enterprise service-oriented architecture. The "Enterprise Services Community" provides the forum for defining enterprise services, while the Independent Software Vendor (IVN) provides the opportunity to work collaboratively with SAP on business solutions and process innovation and integration, leveraging enterprise services. The IVN further empowers customers to be active participants in the SAP ecosystem and key contributors to innovating new business processes relevant to their individual needs.

Co-innovation and open technologies enable customers to improve business processes, go to market faster, and out-think and out-execute the competition. SAP operates in a highly dynamic and increasingly internationalized market where demand for intelligent software services for firms is growing.

5.3 Motives for Internationalisation

SAP is the world's leader in software development and IT services for medium-sized firms which SAP defines through the range of 10 to 2500 employees. With economic globalization stimulating internationalisation of SMEs, and particularly with eastern EU enlargement facilitating SME investment in accession countries, it is obvious that SAP has enormous global market potential. Software development and R&D activities, narrowly defined, have grown strongly at the beginning of the 21st century as is evident from the rapid growth of employment in Germany (at the headquarters in Walldorf in particular).

The US is the global leader in software development, and also the largest OECD market, so that for SAP, it was natural to finally set up a lab in California where activities have grown strongly in the late 1990s. Moreover, in India, the cheapest location of high-quality programming in the Anglo-Saxon world, SAP has become active in order to exploit cost advantages through international outsourcing and offshoring, with offshoring playing the dominant role. Moreover, India is a gateway to the whole Asian market, however, it is clear that SAP will expand its activities in China.

As the enterprise software market naturally is shaped by strong long run price competition, SAP has tried to combine software innovations with strict cost management which includes exploiting opportunities for international outsourcing and for offshoring. Clearly, as intellectual property rights in the software market are not very strong in the world economy, offshoring has been a preferred strategy.

One may summarize the motives for internationalisation as follows:

- Pressure to follow main customers in their internationalisation (industry and services);
- Technology-sourcing, namely picking up innovations and new trends through presence in lead markets (US, EU);
- Creating and exploiting network effects: as more and more SMEs cooperate or are engaged in market-based transactions there are major network effects to be exploited, particularly as SAP is an industry leader;
- Exploiting opportunities for cost reduction: by efficiently combining ideas and skills from the US, Europe and Asia, the high-technology company SAP is able to benefit from the diversity of skills and concepts around the globe;
- With economic globalization continuing, there are new opportunities for newcomers to enter growing intermediate product markets – in a mirror perspective that includes new opportunities for outsourcing as emphasized by ONO (2000); this means that SAP also faces new opportunities as customer-supplier relations can optimally be structured only through modern IT services; and,
- If ICT expansion brings about a rising technological progress rate there will also emerge new outsourcing opportunities (Bartel/Lach/Sicherman, 2005): again the leading software firm SAP may expect strong long run market growth in this context.

SAP is a driver of economic globalization through its impulses for creating digital international business networks. At the same time SAP stands to benefit from an ongoing economic globalization.

5.4 SAP Research and Innovation

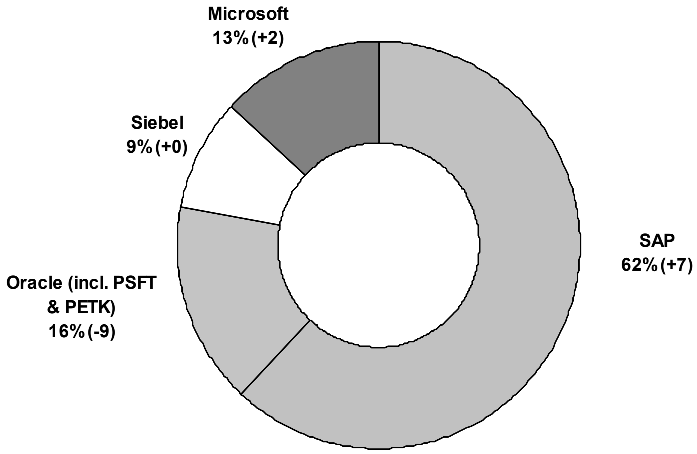
SAP has major research and development activities in Germany and the US, but also in India where subsidiaries and partners are developing intermediate products for new software. Besides Walldort and Potsdam in Germany, the US SAP lab is a crucial center of innovative activity. SAP Labs U.S. is located in Palo Alto, CA, and was the first SP Lab established outside of Germany. SAP Labs U.S. started with 25 employees in 1996. At the beginning of 2006 more than 1500 employees were working in Palo Alto. SAP can thus tap the pool of the human capital in the Silicon Valley, create strategic partnerships in the US, and more easily expand in the large US market. SAP Labs U.S. wants to create and deepen partner relationships that drive networked collective innovation. The SAP lab also builds an innovative community at various levels by getting involved in local business, cooperating with academic researchers and supporting specific projects and initiatives such as the 130,00-strong SAP Developer Network. According to SAP, the Lab actively hires talents in North America, and often places people with strong industry-specific expertise in satellite offices that are located close to those industries; e.g. experts in government and public sector activities reside in Washington, DC, whereas experts in oil and gas work out of Dallas, Texas. SAP Lab u.S. has developed strategic relationships with various universities, including Stanford University, Carnegie Mellon, MIT, Rutgers University, Software Developer's Forum, Stanford Global Supply Chain Management Forum, Intel, Microsoft and others. SAP Labs U.S. has been a quite valuable asset in developing software innovations; it has contributed to the SAP NetWeaver platform and the Enterprise Service Architecture (ESA) framework.

In 1998, SAP created SAP Labs India which is one of the fastest growing SAP subsidiaries. The Labs India are considered a crucial element of SAP's global development network. SAP Labs are role models for internationally distributed development organizations. In 2006 more than 2000 employees of SAP Labs India have contributed to the overall success of SAP.

5.5 Summary

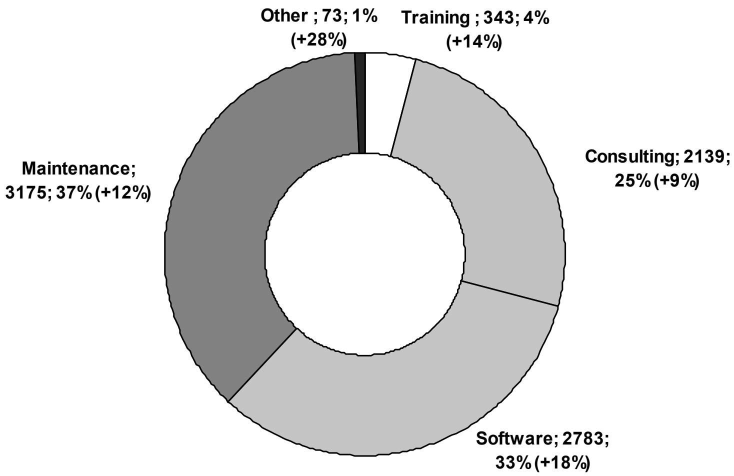
SAP is a global player in enterprise software. Disregarding the very small SMEs, it is fair to say that SAP indeed is a global leader and enjoys in its market a market share of more than 50%. SAP has been successful in expanding both in the US and Asia; the company has built a world-class international network of software developers and system analysts. SAP has been a successful innovative and increasingly internationalized company which has largely relied on internal growth, but has also occassionally acquired small innovative firms which reinforce the company's development portfolio. SAP has called for institutional reforms in Germany and the EU, respectively, so that institutions and rules, including those affecting labour markets, are better suited to the needs of modern IT firms. SAP has created broad networks of partners in the business community and in academia worldwide. Moreover, SAP has actively supported ICT modernization initiatives in Germany/the EU, the US and Asia. SAP is one of Europe's few globally leading companies in software development. One can only hope that institutional modernization in the Community, and policy reforms in the context of the Lisbon Agenda, will reinforce the opportunities for modern software companies which offer attractive jobs, high remuneration and crucial products for economic modernization and for raising productivity in the business community and in the public sector.

5.6 Selected Figures and Tables/Data Analysis



Source: SAP Annual Report 2005
Note: Product related revenues (software licenses 2,8 billion €, maintaining 3,2 billion €) are much higher than service oriented revenues (consulting 2,1 billion € and teaching 3 million €) in 2005.

Fig. 90. Relative Peer Group Share



in Euro million / percent / change since 2004
Source: SAP Annual Report 2005

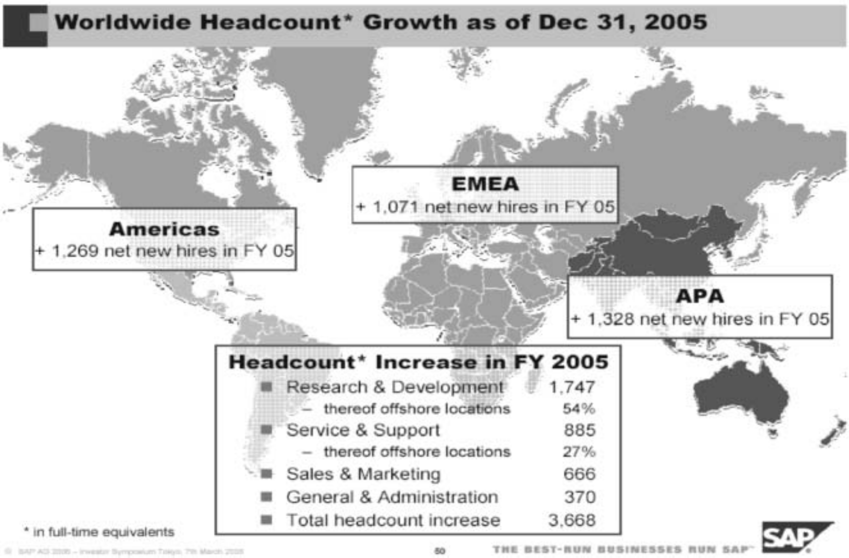
Fig. 91. Revenues Breakdown - by Activity

Table 44. Worldwide Headcount Dec 31, 2005*

	12/2005	09/2005	12/2004	% seq. Dec/Sep	% yoy. 05/04
Group	**35.873**	**35.022**	**32.205**	**2**	**11**
EMEA	21.729	21.439	20.658	1	5
Americas	7.953	7.617	6.684	4	19
APA	6.191	5.966	4.863	4	27
R&D	**11.629**	**11.132**	**9.882**	**4**	**18**
Services & Support	**14.390**	**14.245**	**13.505**	**1**	**7**
Sales & Marketing	**6.249**	**6.165**	**5.583**	**1**	**12**
General & Administration	**3.605**	**3.480**	**3.235**	**4**	**11**
	FY 2005	**Q4 2005**	**Q3 2005**	**Q2 2005**	**Q1 2005**
Net new hires	**3.668**	**851**	**927**	**886**	**1.004**

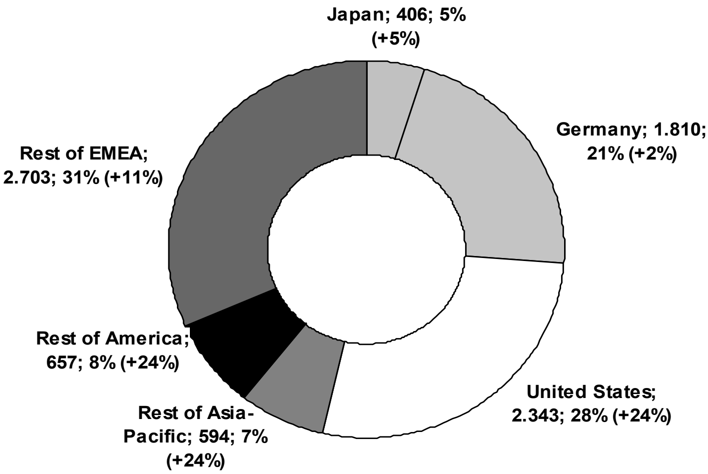
*in full time equivalents

Source: 'Presentation 'Accelerated Growth from Smart Investments', SAP Japan



Source: 'Presentation 'Accelerated Growth from Smart Investments', SAP Japan, 2006

Fig. 92. Worldwide Growth of Headcount Dec 31, 2005



in Euro million / percent / change since 2004
Source: SAP Annual Report 2005

Fig. 93. Revenue Breakdown by Sales Destination

Table 45. Financial Figures of SAP, Key Figures - Full Year 2005

	Financial Year 2005 in millions Euro	Δ % compared to FY 2004
Software Revenues	2.783	18
Total Revenues	8.513	13
Operating income	2.331	16
Operating income margin as a % of sales	27,4 %	0,5 percentage points
Net income (after tax)	1.496	14
Net income margin as a % of sales	17,6 %	0,2 percentage points

Source: 'Presentation 'Accelerated Growth from Smart Investments', SAP Japan, 2006

5.7 References

The case study is based on various sources, including company sources:
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For breakdown of employees by geographies see XLS on SAP Investor Homepage:
http://www.sap.com/company/investor/reports/quarterlyreport/2006/xls/SAP_Q1_2006_e_final.xls
For further detailed information please check and the newly released SAP Annual Report 2005:
http://www.sap.com/company/investor/reports/annualreport/2005/pdf/2005_SAP_Annual_Report.pdf

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6 Light Case-Studies

6.1 Tumbleweed Communications Bulgaria and East-Europe

- Ownership: USA
- Location: Bulgaria, Sofia
- Size: 90 employees
- Activities: R&D, sales, support, services and training in internet security solutions

Tumbleweed was founded by Jeffrey C. Smith in 1993 and is headquartered in the US (Redwood City, California). Recognizing that email communication was going to become a major tool for business communications, Jeffrey Smith and Jean Christophe Bandini used Jeff's home as a base for operations and set out to create technology that would allow for secure communication. Envoy, their first solution, was a tool for electronically distributing pictures of documents, regardless of the application used to create the original source material. Shortly after they shipped it in 1993, WordPerfect purchased the solution for its WordPerfect Suite in 1994. In 1994, Tumbleweed created an email firewall solution to extend standard email and enable secure communications with customers, suppliers, and business partners. Tumbleweed's innovation has resulted in over 20 patents, some of which are licensed by other vendors in the field. Tumbleweed's product portfolio has grown over the last decade, with communication security solutions for email, file transfer, and identity validation. Tumbleweed has recently been selected as one of IT Week's Top 50 Technology Innovators of 2005. The IT Week Top 50 Technology Innovators of 2005 award recognizes companies, both large and small, in a variety of areas and technology fields that are developing today's most innovative technologies.

The company has been listed on NASDAQ since 1999 and has about 270 full-time employees. Revenues amounted to 50 Million $ in 2005.

Tumbleweed Communications Corp. provides secure Internet communication solutions for enterprises and government. Its products include: MailGate, a suite of products, such as email security solution, antispam/antivirus solution, email relay, and secure email software solution for protecting, filtering, monitoring, and securing enterprise email communications; Tumbleweed SecureTransport, an enterprise-class secure file transfer solution for moving financial transactions, business files, documents, extensible markup language, and electronic data interchange transactions over the Internet and private Internet protocol networks; Valicert Validation Authority, an online certificate status protocol responder that validates the revocation status of digital certificate in real-time.

The company also offers professional services to its customers, which include support and maintenance, integration consulting, and technical training. It serves financial services, healthcare, and government industries in North America, Europe, Asia, and Australia. The company sells its products and services directly, as well as through channel partners to enterprises and governments. They have served 1000 cutomors, among which representative customers such as: ABN Amro, Bank of America Securities, Catholic Healthcare West, JP Morgan Chase & Co., the US Food and Drug Administration, the US Department of Defense, and the US Navy and Marine Corps. Today there are Tumbleweed offices in the US (California, New York, Chicago, Washington DC) and in the UK, Bulgaria and Singapore.

In 2003 Tumbleweed merged with ValiCert. Both Californian firms had been through significant layoffs and retrenchment. Combined, the two Redwood City, California based companies employed 150 engineers, almost evenly divided between California, the Tumbleweed operation in Bulgaria, and the India office started by ValiCert. In Bulgaria, engineers wrote and tested software, and scanned millions of e-mails daily for traces of spam. In India (Bangelore), engineers tested software, fixed bugs and created new versions of older products. The experience of ValiCert in offshoring to India had not been without problems. According to Scott Thurm of the Wallstreet Journal:”Misunderstandings started right away. U.S. executives wanted programmers with eight to 10 years of experience, typical of ValiCert's U.S. employees. But such "career programmers" are rare in India, where the average age of engineers is 26. Most seek management jobs after four or five years. Expertise in security technology, key to ValiCert's products, was even rarer.”

In May 2004, Tubleweed announced its move out of India, closing down the ValiCerts office in Bangalore. At the same time, it announced its plan to extend the existing business operations in Sofia, Bulgaria, by 50% by the end of 2004.

In 2005, Tumbleweed Bulgaria announced the creation of an AntiSpam research team in Sofia: “We are opening new positions in Sofia in order to build up a Research group which will be focused towards new technologies, and to invent the technologies of tomorrow to fight against spam,” (Eric Dumas, Tumbleweed Vice President and Bulgaria Country Manager). “On top of this research team, we are too creating a new team whose responsibility will be to take ownership and to improve our overall AntiSpam Engine. Those two teams will join the already existing Sofia Tumbleweed Message Protection Lab”.

Besides being an increasingly important location for R&D and product development, Bulgaria has also increased as a market for Tumbleweed. To name one example, Bulgaria's leading GSM operator MobilTel, chose Tumbleweed in 2005 to provide it with its MailGate E-mail Firewall to filter and secure email traffic.

Besides the availability of a large pool of talented and qualified IT professionals in Bulgaria, this case accords with the recorded rise of Bulgaria as destination of outsourcing and foreign direct investments. For example, according to A.T. Kearney, Bulgaria makes its debut on its 15th position in the top 40 outsourcing destinations for 2005 (A.T.Kearney: 2005 Global Services Location Index, November 2005). Moreover, with USD 2.5 bln FDI, Bulgaria ranks 1st in the region of South-East Europe and 12th in the global FDI index of UNCTAD for 2004 (World Investment Report 2004 - edition 2005, 29 September).

6.2 Kring Technologies

– Ownership: Danish
– Location: Denmark, Copenhagen
– Size: 130 employees global, 15 in Denmark
– Activities: Customized ICT services

KRING Technologies provides customized IT services and consulting to clients worldwide. By offering specialized services in outsourced software development, Kring allows their clients to focus on their core competencies freeing up time for innovation and value creation by outsourcing non-core activities. The service offerings are based on an understanding of the client's business processes and functional requirements. The business domain knowledge is then applied to develop software solutions by utilizing the available pool of technical skills and methodologies. According to KRING Technologies, it offers Western project management and quality processes combined with highly qualified technical skills through their offshore facilities in India and the Ukraine. "Our global-source offshore model provides substantial cost-savings for our clients, enabling them to shift from a fixed to a variable IT service cost-structure. Furthermore, by taking advantage of the global-source offshore model, clients obtain increased resource scalability with flexible virtual teams, access to various IT competencies and new technologies. We work with companies of all sizes, and our service offerings cater to multiple industry domains, following a full or partial systems development life cycle. Optimally, we aim to provide a customized service catering to the client's specific needs, thus benefiting from the broad spectrum of technology tools, quality services and low cost development, which KRING Technologies has to offer."

KRING can offer access to approximately 300 highly qualified developers, software engineers, testers etc., in their 'near-shore and offshore' facilities in the Ukraine and India.

KRING has its Head Offices in Copenhagen, Denmark. These were consolidated in Copenhagen in 2005 and now KRING's top management operates from this office where sales initiatives, account management, development and project management activities are carried out from here.

KRING's East Asian development center is situated in the city of Gurgaon, 17 km from the capital city of India, New Delhi. Gurgaon is an IT hub of Northern India. The development center provides clients the benefits of offshore development. KRING's major software development projects are being done at this location wherein KRING replicates client's IT environments, training teams, setting up communication and security systems, and integrating development processes with theirs to ensure the offshore development team is an efficient and seamless extension of the client's development facilities.

In the second half of 2005, KRING Technologies expanded its operations to Central and Eastern Europe by opening a development centre in Kiev, Ukraine. This was accomplished by taking over the Danish company Developmate A/S, which has been the leading force in software outsourcing initiatives from Denmark to Eastern Europe. The expansion was done in order to provide clients with a wider range of development resources and at the same time ensure projects against any instability.

KRING strongly believes in the concept of 'Global-Source', where it feels that individual outsourcing destinations have one or more innate advantages in terms of techno-functional skills, linguistic skills, geographical & political advantages, economics of delivery, etc.. KRING has established India as its first base for offshore delivery, and India is still an attractive destination at this stage. However, Kring also believes that other countries in Eastern Europe, China, and South Asia Pacific also have some innate advantages and these countries are quickly catching-up in becoming viable IT outsourcing service providers. Therefore KRING now has a 'near-shore' center in Ukraine, and it is exploring the options to establish offshore development centers at other destinations such as, Belarus, Armenia, South Africa, China, Bangladesh, Indonesia, Philippines, etc..

Customers of KRING belong to the following categories: Telecom/Wireless; Healthcare/Pharmaceuticals; Finance and Insurance; Retail and Consumer Goods; Manufacturing; Information Technology; and Travel.

Part of the Kring-business model is to be committed to form strategic relations with other organizations that are mutually beneficial, and to ultimately create value for the clients. Kring is partner with organizations such as, Microsoft, Oracle, IBM, Web500, DIR, Alliance-Controls and Cutting the Wires, and jointly works with them to provide value-added services. Different types of partners are searched for including:

- Business Partners;
- Technology Partners;
- Solution Partners; and,
- Research&Education Partners.

Throughout the past 10 months, KRING Technologies A/S has been involved in a campaign to drive exports in Norway and Sweden in collaboration with the Danish Trade Council and 10 other Danish ICT companies. The first Norwegian clients are now in place and as a consequence, KRING has established an office in Oslo to service the Norwegian market. "This is a strategically important step towards reaching our goal of maintaining the position as the leading provider of offshore software development solutions in Scandinavia. By opening an office in Norway we are now one step closer to having a complete coverage of the Scandinavian marketplace", states CEO Mikael Munck. KRING Technologies Norway will be managed by the Norwegian Hans Henrik Holven, who has run his own company Insight Financial Systems, since 1995, prior to it being sold to the Bonnier Group. Insight had utilized software development in St. Petersburg, Russia, and as such, Hans Henrik has 10 years of experience in offshore outsourcing.

6.3 SAP Labs Bulgaria

- Ownership: German
- Location: Bulgaria, Sofia
- Size: 270
- Activities: Software development

SAP Bulgaria was founded in 2000, and in 2002, SAP Labs Bulgaria started. Over the last years, SAP Bulgaria has been the fastest growing subsidiary of SAP worldwide. SAP Labs Bulgaria is focused on developing the Java stack of SAP Web Application Server - a scalable and reliable component platform. The company has been involved in the area of innovative J2EE technologies for more than three years, working closely with the different development sites of SAP worldwide and keeping in-line with leading-edge technology. Plamen Tilev, the managing director of SAP Bulgaria says: "much of this work is only done in Sofia and SAP's German headquarters". Currently, SAP has 270 people based in Sofia and according to Tilev, SAP plans to "double that in two years time".

Founded in 1972, SAP is a market leader in providing collaborative business solutions for all types of industries and major markets. With 12 million users, and more than 1,500 partners, SAP is the world's largest inter-enterprise software company and the world's third-largest independent software provider. Today, SAP employs about 34,000 people in more than 50 countries. SAP Labs represents a dynamic community within SAP's global research and development organization, sharing insights and promoting creativity on a worldwide basis. With operations in Bulgaria, France, India, Israel, Japan, and North America, SAP Labs integrates ideas and leading-edge technologies that address the needs of specific industries and geographic regions.

The rise of open technologies has altered the competitive landscape for business leaders. SAP's answer to this challenge is open business integration – the SAP NetWeaver. As a comprehensive integration and application platform, SAP NetWeaver works with the companies existing IT infrastructure to enable and manage changes. Using the SAP NetWeaver, it is easy to design, build, implement, and execute new business strategies and processes. SAP NetWeaver allows for driving innovations throughout the organizations by combining existing systems while maintaining a sustainable cost structure.

SAP Labs Bulgaria is focused on developing key components of the SAP NetWeaver Platform like SAP J2EE Engine, an integral part of SAP's application platform and, SAP Web Application Server, Enterprise Service Infrastructure, the technology to service-enable SAP products and Composite Application Framework, the framework for building SAP xApps.

Around 50 Bulgarian and multi-national companies operate in Bulgaria using SAP systems. But this market was not the only reason to invest in Bulgaria. SAP's software development subsidiary in Sofia was established in May 2000 with a team of 60 programmers who worked on Java Enterprise Server projects. In 2002, the company became part of SAP Labs network. Currently, hundreds of Bulgarians work for SAP in Sofia, as well as in the company's headquarters in the German city of Altdorf. According to company board member Klaus Heinrich: "The choice of Bulgaria as a development centre is determined both by the skills of Bulgarian programmers and by the similarity in cultures". Heinrich added that they were "not here because of the low salaries only, but because of the knowledge, skills and enthusiasm of Bulgarian specialists" (See: Ivan Vatahov in The SofiaEchoCom, December 2005).

According to Bill Robinson for Outsourcing Journal (August 2005), Russia and Eastern Europe are collectively stepping forward in a big way to grab more and more of this business. Their goal is to find customers disenchanted with the Indian outsourcing providers. Bulgaria competes with locations in China, The Philippines, Vietnam, etc.. Why Bulgaria? Bulgaria has an unusually well-developed educational system specializing in electronics, engineering, and computer sciences. There are more than 47 universities in Bulgaria, located in 26 different towns. At any one time, there are more than 5,000 Bulgarian students majoring in computer science and another 5,000 majoring in electrical engineering, mathematics, physics, and biotechnology. Bulgaria's advanced education is up with the top countries in the world, ranking fifth amongst all countries in sciences, and eleventh in mathematics, according to The World Bank and The Economist. It also ranks second in the world in IQ tests (MENSA International), and ranked 8th globally in terms of the number of certified IT professionals per inhabitant, according to the Brainbench Global IT Report.

SAP, indeed did not send unimportant work to Bulgaria; to the contrary, SAP is placing a big bet by having its Bulgarian counterparts focus on the all-important Java software development area for its worldwide product line. Steve Keil, the CEO of Sofia-based Sciant, an outsourcing service provider, says that Bulgaria is more innovative: "When SAP wanted to develop new, really advanced software, they chose not to send their NetWeaver Java-based platform to their big, existing operation in India but made the bold decision to send it here to Bulgaria."

However, SAP's success could create complications for a Bulgarian company interested in finding the right technical personnel at the right rates. "SAP has something like $14 billion in cash, comes in recruiting 300 developers, and pays well over the market rate. Now there's a huge sucking sound as SAP takes the lower and medium-level programming talent off the market," Keil observes. He says Bull, Siemens Business Services, Ericsson, and others are also now in Bulgaria, "which makes the recruitment cycle much longer for us." Given what's happening in India, these are two big problems (higher wages and longer ramp-up time) for Bulgaria to overcome. In order to make Sciant's offerings more competitive, Keil recently set up an operation in Vietnam, where he hopes to integrate its lower local costs and salaries with the advanced complex code and project management skills of his staff in Sofia. The goal: to overcome India's rising pricing. According to executives at firms such as Sapient and Capgemini, customers like this hybrid model.

But SAP also invests in education. A special SAP programme is to be launched in three Bulgarian universities, aimed at providing students with more practical skills in Java technology, SAP Labs Bulgaria manager Plamen Tilev said.

6.4 Delta Singular

- Ownership: Greek
- Location: Greece
- Size: 1500 employees in total
- Activities: Software products, IT outsourcing services and System integration

Delta Singular Group is a key player in Greece and Southeastern Europe. It has the ambition and vision to successfully meet the demanding requirements of both regional and international IT markets. Delta Singular is the result of a merger between Delta Informatics SA and Singular SA.

One of the leading IT providers in Greece, Delta Informatics, was established in 1984 by Alpha Credit Bank, following the acquisition of the service bureau of Doxiadis Associates Computer Center SA. Focusing on the banking sector and offering integrated end-to-end IT services to major private and public institutions, Delta Informatics was listed on the Athens Stock Exchange in 1994. Specializing in bank card management services, Delta Informatics engaged in the design, production and processing of credit and debit cards issued by 34 major banks in both Greece and abroad. Moreover, the company created the DELTANET transaction network, which supported ATM banking transactions. Having established a nationwide reputation as an efficient and reliable service provider, Delta Informatics was entrusted with the national, municipal and EU elections in Greece since 1981.

SINGULAR SA was also founded in 1984. Singular concentrated on the production and distribution of financial, accounting, and tax-related software application packages for the Greek business market. In 1988, the company established Singular Northern Greece SA to promote its products and services in Northern Greece and the neighboring Balkan states. In the early 1990s, Singular expanded its operations, offering IT solutions, gradually evolving into a systems integrator. In 1994, Singular was the first Greek IT company to be listed on the Athens Stock Exchange. Based on key acquisitions, as well as strategic agreements involving the Internet, e-commerce, integrated customer relations management solutions and the representation of international firms, Singular gained recognition as one of the leading IT groups in Greece.

The merger of Delta Informatics and Singular in 2000 is defined by their complementary operations and areas of expertise in both the public and private sectors.

Singular contributed its leading position and technological edge in the business software and systems integration market, along with its Internet and e-business specialization, extensive and reliable sales network and strong international presence. Likewise, Delta Informatics contributed its experience and know-how in providing outsourcing services, especially to the highly demanding financial and banking sectors, as well as to major public and private institutions. Having established a leading position in the IT sector in terms of both annual turnover and range of activities, the Delta Singular Group engages in three principal lines of business:

- Software Products,
- IT Outsourcing Services, and
- Systems Integration.

The Delta Singular Group intends to become a leader in Southeastern Europe by aggressively marketing and promoting its products and services throughout the region. The Singular - Delta Informatics merger expanded the range of exportable products, while the resulting synergies allowed entry into new markets. Through its subsidiaries, the Group develops, distributes and supports integrated ERP and CRM solutions, as well as retail applications, adapted to different local business practices and levels of economic development. Moreover, the Group's IT Outsourcing Services unit has established an international presence by marketing its financial-sector services to neighbouring countries. The Delta Singular Group is consolidating its position as a long-term partner to both Greek and international enterprises. This is achieved by closely tracking evolving requirements in today's global business environment and providing training programs that improve its human resources. The Group is currently active in the U.K., Germany, Cyprus, Holland, Poland, the Czech Republic, Hungary, the Balkan states and the U.A.E..

The Group's Software Products unit engages in the development and marketing of business software applications and related services (such as business and project management & application consulting, customized software development and integration services, as well as training & maintenance services), and also promotes and supports third-party products. This unit is comprised of the following companies: Singular Software, Singular Retail Business, Scan Group, Singular Hospitality Solutions, Baan Eastern Europe Localisation Centre, Alpha Nova, and Computer Team. The Software Products unit offers a complete range of business applications that includes: enterprise resource planning (ERP) systems, trade & financial applications, retail outlet management systems, human resources & payroll management systems, customer relations management (CRM) applications, hospitality applications and health care management systems. Software application support services include: Software integration consulting, business automation management, training, product & systems maintenance, e-learning and e-mail & phone-based support, as well as group seminars on Delta Singular applications offered through Delta Singular Educational Services. Customer Base & Distribution Network: Currently, the Software Products unit supplies 45,000 business customers throughout Greece through a network of 370 associates and business partners. Software product distribution and support is handled by a nationwide network of Singular Business Centers (SBCs). Having successfully transferred most small and mid-size business customer support functions to these SBCs, the Group has created a strong, dedicated sales network that effectively distributes and supports its entire product line.

The Delta Singular IT Outsourcing Services unit offers integrated solutions to the Greek and European market. The Delta Singular Group is a leading provider of IT outsourcing services to financial and banking institutions, as well as major enterprises and organizations both in the private and public sector. The Group undertakes large, complex projects, involving heavy data volume loads subject to strict delivery terms and data security requirements, such as: Transaction Systems, include services that directly or indirectly support transaction or fund transfer procedures, and involve credit/debit card development & management, ATM management and loan management systems, e-payments related to e-business applications, etc.. These services have established Delta Singular as the leading outsourcing services provider and most reliable partner to financial institutions in Greece. Business Applications, involve customized services to corporate clients and include: stock register management and other applications for listed and soon to be taken public companies, payroll and human resources management systems, national election support services, accreditation support services for major events (international sports events, conferences, etc.), as well as disaster recovery services ensuring the uninterrupted flow of the services provided. The Group's disaster recovery facilities feature state-of-the-art systems handling access control & security and personnel & systems protection, as well as alternative operating methods and means of telecommunication. Basic Workflow and Infrastructure Services, include mass or selective printing and mailing, data entry, personalized bank cards, etc.. Phone Services, meet the specific requirements of banking and financial institutions, as well as those of major private and public enterprises. The services offered include, credit card authorization/approval, collections, helpdesk and customer support. The Delta Singular Group offers end-to-end e-business solutions adapted to today's demanding business environment through its Internet Hellas and One World subsidiaries. Business Internet Telecom Services: Advanced Internet-based telecommunication services offering a range of audio and video data transmission services. Internet Data Center Services: Services offered by Internet Hellas' state-of-the-art Internet data center.

Delta Singular Human Resources

Area	1998	1999	2000	31/12/2001
Administration & Finance	38	62	78	155
Sales & Marketing	50	54	51	185
Professional Services	80	140	191	608
R & D	54	51	68	104
Support Services				504
Grant Total	222	307	388	1,556

6.5 OMRON Manufacturing of The Netherlands BV (OMN)

- Ownership: OMRON Corporation, Japan.
- Location: s'Hertogenbosch, (NutsII region: North Brabant), The Netherlands
- Size: 240 employees in 2004
- Activities: R&D, Manufacturing and Marketing of measurement and control equipment for industrial market; European Services & Repair Centre and European logistics Centre.

Omron Corporation has its headquarters in Japan. It is a global player in sensing and control components and automated systems which find their way in a wide variety of sectors such as industrial automation, home appliances & office equipment, automobiles, social & financial systems, and healthcare. Of the total of 23,000 employees, 15,000 are in overseas affiliates, spread out across 35 countries. The European organization has its headquarters near Schiphol airport in the Netherlands.

The plan to establish the manufacturing plant in 1990 was made at the EHQ in Hoofdorp. Besides the proximity to EHQ, the location was chosen because of its central location in Europe, language skills and labour potential in general, and trust in the region based on Fuji's decision to invest in the same region.

R&D activities started in 1992. In 1993 a logistics unit was set up. The formerly outsourced logistics to external distributors in several countries were internalized and concentrated in s'Hertogenbosch because it appeared to be cheaper. In 1995, the 'orderprocessing' activity was re-located from Switserland. In 1996, service & repair had been concentrated and located at the site of OMN. Employment increased to 220 employees in 1995. Ten years later, the total employed is 240, however, it should be noted that there has been a shift from manufacturing employment to service activities. The R&D unit of 15 people has grown to 40 and was complemented with a group of 15 people in marketing two years ago. Manufacturing employment has decreased from 170 in 1995 to 120 in 2004. New products are less labour-intensive and for some products, manufacturing had been relocated to the OMRON affiliates in China, not only because it was cheaper, but also because OMN has increasingly focused on industrial markets, and industrial clients do not want standard applications.

Purchasing (goods and services) amounts to 57% of total sales. In the first few years about 95% of total purchases originated from Japanese affiliates. At present it is about 50%, so there had been a strong shift towards European sourcing. First they have searched and tried regional suppliers, because proximity is helpful in establishing long term, knowledge intensive partnerships. Later the 'search area' for suppliers was extended to other Dutch regions and other European countries. Of total purchases, 8% originates from the region, 17% from the rest of the country, and 20 % from the rest of Europe.

Out of total sales, 90% goes to Europe, 6% to Africa, and 4% to Japan. About 10% is for the Dutch market. They also deliver to OMRON in Germany. The German site also performs R&D but they are specialized in sensor technology and

OMN in "communication protocols" and 'besturingssytemen'. Although the core R&D is located in Japan, OMN has developed into a Center of Excellence for expertise that is not available in Japan.

"Concerning R&D we do not like to cooperate with universities. We have co-operated with Stork and we cooperate with our German affiliate and the most interesting research institutes for us are also in Germany".

6.6 Xilinx Ireland

- Ownership: US
- Location: Ireland, Dublin
- Size: 450 employees (2,600 worlswide)
- Activities: Semiconductor design and production

In July 2005, Xilinx had announced its intention to establish Xilinx Research Labs at its European Headquarters in Ireland, and the new building has been opened in October 2005. This will be a new, high level research operation which will carry out globally relevant work for Xilinx. The strategically important facility will work in tandem with Xilinx Research Labs in the United States. Xilinx Research Labs will involve an investment of €7,500,000, and its establishment is supported by IDA Ireland.

The mission of Xilinx Research Labs is to carry out speculative research to invent and discover technological solutions that create new business opportunities for Xilinx, or significantly advance its current business. The Irish centre will specialise in the field of networking and emerging network architectures, an area in which programmable microchips can make a major contribution due to their versatility and high performance characteristics.

"Research and invention are the lifeblood of a pioneering firm like Xilinx," said Ivo Bolsens, Vice President and Chief Technology Officer for Xilinx. "The establishment of Xilinx Research Laboratories in Ireland is of immense significance due to the strategically vital contribution which fundamental research makes to our global corporation."

The company will initially recruit PhD qualified engineers as Principal Researchers, and PhD or experienced Masters Degrees holders as Staff Research Engineers. Xilinx Research Labs Ireland will also engage strongly in collaborative research work with other academic and commercial research facilities in Ireland.

Xilinx is one of Ireland's leading foreign direct investment partners. The company, which currently employs 450 in Ireland, designs and produces programmable semiconductor chips that are capable of being programmed individually for use in a wide range of electronic systems. Since establishing its Dublin base in 1995, Xilinx has invested about EURO 125 million in the largest facility operated by Xilinx outside of North America.

Xilinx programmable microchips are instrumental in the development of new information and communication technologies throughout the world, with applications ranging from consumer electronics through to mission critical systems. Xilinx is the leading provider of programmable logic solutions, with 51% market segment share. The company develops and provides the software tools necessary to programme these devices, as well as predefined system functions that customers load as software into the microchips.

This is the first time that Xilinx has located a research lab operation of this nature outside of the United States. It is seen locally as a significant endorsement by the corporation of the strong performance to date of its European operations headquartered in Dublin. Xilinx currently operates an advanced R&D, engineering and operations centre in Dublin.

"The multifunctional nature of our business in Ireland provides a huge depth of opportunity for our employees where individuals have total visibility on the international organisation and its activities," said Xilinx Ireland's McCambridge. "Xilinx in Ireland is a fully integrated part of the global business which operates on the basis of cohesive international teams. Everyone here is aware that the impact of what they do can have tangible benefits across the entire organisation and this is very empowering."

Some of the highest ranking international responsibilities in Finance, Legal, IT, Strategic Marketing and overall Business Operations Management, reside at Xilinx European headquarters in Ireland. For example, Xilinx recently appointed an Irishman, Kevin Cooney, as global Chief Information Officer based in Ireland.

"Xilinx in Ireland has won some very high profile corporate responsibilities and it continues to do so year on year based on the quality of what we are achieving and the leadership roles which our staff have adopted," added McCambridge.

Table 46. Financial Performance of Xilinx Inc. in 2004

Revenues	$1,397,846,000
Operating Income	$ 327,135,000
Net Income	$ 302,989,000
Cash and Investments	$1,566,631,000
Revenue per Employee	$ 526,000

Xilinx Inc. currently has its worldwide headquarters in San Jose, California and a European headquarters in Dublin, Ireland. In addition, Xilinx recently announced the opening of a Singapore office to serve as the headquarters for the operations in Asia Pacific and Japan. The revenue composition by geography has changed markedly over the last five years. Sales to Asia Pacific and Japan have grown significantly due to increased demand from customers in the consumer sector as well as increased outsourcing by customers in North America and Europe. Xilinx sales into Asia Pacific and Japan represented 39% of revenues in fiscal 2004, up from 30% in fiscal 2003 and up from 11% in fiscal 1999. By providing infrastructure and support to all of the activities in the region, the Singapore facility will bring Xilinx closer to its customers and partners in the region, facilitating the Company's growth in Asia at a time when regional demand for semiconductors, and PLDs specifically, is rapidly increasing. "With global operations in the United States, Ireland, and Singapore, we are well on our way to establishing a global footprint" (Willem Roelandts, President, Chief Executive Officer and Chairman of the Board, 2005).

McCambridge, who is the managing director of Xilinx Ireland, and also vice-president for Europe at Xilinx, was one of the original bands of senior technology executives who lobbied for the Government to look away from manufacturing and the low wage model for inward investment, focusing instead on the more lucrative field of R&D and innovation.

Regarded as a jewel in the crown of Ireland's ICT community, Xilinx has designated Ireland as its regional headquarters for Europe, which now accounts for 21pc of group turnover. Xilinx chief technology officer Ivo Bolsens also cites the existence of Lucent Technologies Bell Labs and the new Centre for Telecommunications Value Chain Driven Research at Trinity College Dublin as a catalyst for R&D activity in Ireland.

Performing the official opening of the new building at Citywest, Minister for Enterprise, Trade and Employment Micheál Martin TD commented: "This investment by Xilinx Ireland in R&D further enhances the company's profile as a model of how an international company in Ireland can develop beyond its original mandate to become a key link in the company's global chain. The company has expanded from an initial manufacturing operation to a European headquarters operation, with global responsibility for certain product lines and home to "corporate centres of excellence, with a strong culture of creativity and innovation."

In an interview with siliconrepublic.com (28-10-2005) McCambridge explained that collaboration, cross-pollination of teams and collective research between companies, universities and state-backed labs, are vital to establishing Ireland as a vibrant location to locate R&D and encourage innovation. "If our researchers are just going to do their work and there's no interaction with the universities then the viability of the Irish economy will be weakened. Therefore we need to produce more engineers from our colleges."

"Companies that plan to conduct research here should move away from the idea of just research and move towards actual innovation bringing together the strengths of teamwork with their customers and academic partners." McCambridge continued: "It is important that industry, Science Foundation Ireland and the universities work together as a team.

6.7 CertiCon

- Ownership: Czech (and others)
- Location: Czech Republic
- Size: 70 employees
- Activities: Customer-tailored software design, development, diagnostics and testing services

CERTICON Corp. was founded in 1996, originally as a spin-off company of the Czech Technical University in Prague. It is now an indipendant, private Czech company that provides full customer-tailored software design, development, diagnostics and testing services. The company produces analogue and digital integrated circuits for highly sophisticated IT applications, specializing in areas of medical aplications, communications, industrial process control, and decision making. Certicon focuses on distinctive complex system development based on object-oriented software technology and distributed, multi-agent, and client-server architectures. Certicon Corp. offers both complex services from within the complete software development life cycle and individual services such as consultancy, software development, feasibility studies, application specification, implementation, system maintenance, and training. In the area of digital, analogue, and/or mixed signal IC design, they produce ASIC chips having several thousand components and using the latest CAD software. The personnel has a high level of expertise, multidisciplinary skills in the software application development, IC design, CAM/CAD, and cybernetics which are continuously extended through collaboration with various technical universities.

CERTICON Corp. is involved in many EU-research projects and is a cofounder of the national Centre for Applied Cybernetics. The Centre is supported by the Czech Ministry of Education programme for research and development implemented with the aim to enlarge cooperation of separate fields, i.e. Czech Academy of Sciences, universities, private industrial organisations, and commercial research companies. The Centre concentrates research potential from the areas of artificial intelligence, automated control, machine perception, and means of automation. Certicon Corp. is a Czech private, non-governmental corporation founded in 1996 to provide consultancy services in the area of automation control. At present, CERTICON Corp. employs about 70 engineers and scientists and produces an annual turnover of 70 million CZK. In 2002, Certicon successfully passed an audit by the BVQI authority and received the ISO 9001:2000 certificate for its quality management system.

Besides the location in Prague, there is a unit located at the Science and Technology Parc of Plzen.

Examples of representative and significant clients are:

- Vitatron B.V., The Netherlands - prominent producer of medical devices. As a highly successful and independent subsidiary of Medtronic Inc., a world leader in medical technology, Vitatron offers a unique technology stream complementary to Medtronic production. Cooperation is focused on design and development of software and integrated circuits for pacing systems.
- Frequentis GmbH., Austria - provider of communication and information systems for safety critical areas and market leader in the field of voice communication in air traffic control. Cooperation is focused on development and integration of software for TETRA - based communication systems and systems for air traffic control.
- Robert Bosch GmbH., Germany, and its division Automotive Aftermarket - leading provider of electronics and diagnostic systems for automotive industry. CERTICON Corp. participates in development of software for testing and diagnostic devices for automobiles of various brands.
- Grundfos A/S, Danemark - world leading producer of industrial pumps. Cooperation was focused on development of computer models and simulations.

6.8 ITProvision

- Ownership: Belgium/Romania
- Location: Belgium and Romania
- Size: 70 employees in Romania
- Activities: Near-shoring in Romania and sales of software

ITprovision is a joint Belgian/Romanian company based in Brasov, in the centre of Romania. Its Belgian sister company is based in Antwerp, Belgium. Both companies are co-owned and managed by Mr. Dan Camarzan in Romania, and Dr. Michel Loots in Belgium. ITprovision is the logical commercial expansion/continuation of the long-term cooperation of Humanity CD Ltd/ Human Info Belgium and Simple Words Romania Srl of the same owners/ managers.

The references include large organizations, governments, and United Nations agencies. ITprovision has 7 years of experience in software and data-processing services. The team of 70 people is seeking long-term partnerships and software outsourcing co-operations.

According to ITprovision, today's successful IT businesses seek software development and data processing partners that are efficient, reliable, and costs-effective. “We are a dynamic, quality-oriented company able to fulfil your needs. ITprovision offers the combined advantages of a Western mentality and Romanian costs-advantage, programming intelligence, and geographical and cultural proximity.”

The two main activities/groups include software programming, and data scanning, entry and mark-up.

Approximately 30 of the 70 employees are engaged in software development (e.g., Project managers, System analysts, Programmers, Computer technicians). The solutions cover a broad range of technology areas with core competency in software (with C and C++ as basis), Internet applications, database design, Web solutions, and CRM. This programming capacity is expanding to support 40 employees.

- Programming languages: C, C++, VC++, VB, Java, .NET
- Technologies: COM/DCOM, ActiveX, Internet Programming, OOP
- Database: Jet (Access), MySql, Oracle, MSSql, PostGRESQL
- Scripting: PHP, Perl, ASP, JavaScript
- Connection Technology: ADO, DAO, ODBC
- Hardware Programming

The second main activity is based on data scanning, entry and mark-up. This team has about 40 employees (e.g., Team leaders, Supervisors, Operators). The basic requirements for programmers is high - every programmer must be a perfect master of C and C++ in addition to the specific language knowledge and experience required by our clients.

Partners and clients include: Autotext; R+R; Humanity CD/Human Info

NGO, Governments and UN Organizations; InfoArt; Chamber of Commerce Brasov

Project References:

- CollOrganizer - a high quality library, books, documents and files manager with extensive features and functionality;
- RTF2HTML - converter from rtf format into html and gml (standard XML for Greenstone digital library);
- SuperSal 2000 and 2001 professional - the best wages (salaries) program ;
- Brasov Chamber of Commerce and Industry Directory (Breviarul agentilor economici);
- Breviar.ccibv.ro - web based application to manage the companies from Brasov (Chamber of Commerce) - web directory and CD-rom application;
- Biblioteca Legislativa - More than 35.000 laws starting with 1818 till now (interlinked and very well classified).

Other services include: Catalogues and Electronic Libraries, and Marketing Services/ Help-Desk.

The main advantage of its location in Brasov, Romania, is based on its human resources. The county of Brasov (historically known as Kronstadt since the time of German settlers in the 18th and 19th century) lies in the middle of Romania, where it is a very important commercial, cultural and social centre. Aside from the tourist and cultural economy of Brasov, there is a thriving banking and commercial activity. Industry and services are becoming the main activity of the county of Brasov, having a high productivity and production capacity. There are 6 universities in Brasov: one state university, Transilvania University of Brasov, and 5 private universities. The foundations of higher education in Brasov were laid in 1940 and since 1990, the Transilvania University has experienced continuous growth with a current enrolment of over 10,000 students, enrolled in the 10 faculties and 2 colleges which offer full-time courses of long duration in over 70 specialisms, full-time courses of short duration in 21 specialisms, and post-graduate courses and PhD research in more than 45 specialisms.

Higher education in IT and electrical engineering started in Brasov in 1962. Until 2001 a number of 3,655 engineers and 1,275 undergraduate engineers have been awarded degrees in Electromechanics, Electrical Engineering, Applied Electronics, Electro-Mechanics, Automation and Information Technologies. Currently about 1,000 students (1st to 5th year of study) are registered for the 5 courses offered by the Faculty, and about 50 graduates are registered for post-graduate (master) study (6th year).

6.9 Infineon Technologies Austria AG

General Description of the Company

Infineon Technologies is a major European producer of semiconductors. The enterprise was founded in 1999 when the semiconductor activities of Siemens were concentrated in a separate company. Infineon’s headquarter is located in Munich, Germany where the company has about 36,000 employees (7,200 in R&D activities) in 100 affiliates around the world.

Infineon Technologies Austria AG (abbr: Infineon Austria) is a 100% affiliate of Infineon Technologies Holding BV (NL) and has its main location in Villach. The company currently employs about 2,600 employees and is one of the largest ICT companies in Austria. The company is also one of the largest corporate R&D performers in the country with over 750 employees working in research and development and a total R&D expenditure of 25% of turnover.

The Infineon Group is organized in four business groups: Wireline Communications (COM), Secure Mobile Solutions (SMS), Automotive & Industrial (AI), and Memory Products (MP). These business groups enjoy a high degree of autonomy in their fields and can plan their production and R&D activities independently. Production and development mandates are given to local affiliates by the business groups.

Increasing Importance Within the Enterprise Group

Infineon Austria considerably benefited from this organisational structure and the high degree of autonomy for the affiliates. The company could gain important production and R&D mandates in the Automotive & Industrial field. In 1997, Villach became a Center of Competence and main location for power electronics in Automotive & Industrial. Sales headquarter functions for Austria, the new EU member states and South Eastern Europe, were transferred to Villach in 1999. In 2003, Villach became the group-wide headquarter of the Automotive & Industrial business group. Furthermore, central IT responsibilities such as the development of software for the production of semiconductors have been shifted to Austria as well. A new relocation project, the closedown of the Munich production site and transfer of parts of the production to Villach and another location in Germany, is currently heavily disputed between the management and the labour union. (FTD, October 14, 2005). The interviewee of Infineon Austria sees favourable framework conditions (taxes, public subsidies, skilled labour, etc.) but also, strong growth in the Automotive & Industrial segment, as the main reasons for Infineon Austria's success in attracting production and R&D mandates within the company group.

International Expansion of Infineon's Activities

As a group-wide headquarter for the Automotive & Industrial business group, Infineon Austria is not only a recipient of production mandates, but is also actively pushing internationalisation. Infineon Austria is currently setting up two affiliates abroad, a new production site in Kulin, Malaysia and a development centre in Bucharest, Romania. Kulin will employ about 1,700 employees and will start operations in March 2006. The Bucharest development centre will start in December 2005 and will have about 50 employees. Both companies will be affiliates of Infineon Austria and accountable to the Villach headquarter.

The motives for Infineon Austria to go abroad were manifold. The first motive based on its need to keep pace with the growing demand in the automotive sector and to increase production and development capacity. Moreover, Infineon Austria is also attracted by the considerably lower wages in Malaysia and Romania. These advantages outweigh disadvantages such as, different business practices, etc.. However, since the two new affiliates of Infineon Austria are not operational yet it is not possible to compare framework conditions and outcomes of the Austrian sites to those in Romania and Malaysia.

As the two new sites are an expansion of Infineon's capacities, there is no relocation of production or R&D from Austria to Romania or Malaysia in the short run. However, in the future, the interviewee sees a division of labour between old and new plants where Austria will focus on R&D, while Malaysia will be more engaged in production activities.

Messages to Policy

The only remaining advantage of Western Europe, in the view of the representative of Infineon Austria, is the level of education and the quality of universities available in Europe. However, Asian countries are catching up fast.

Analysis

Infineon is an example for the recent trend of Multinational enterprises (MNEs) giving themselves a more decentralized organisational structure, as analyzed by Zanfei (2000) and others. Zanfei explains the need for autonomy in research and development with the existence of context-specific knowledge and the formation of external networks to access this knowledge. Moreover, there is horizontal competition within the MNE group between affiliates for production mandates.

Infineon Austria has benefited considerably from this autonomy and is now even setting up own affiliates. In this perspective, differences between foreign-owned and domestically-owned enterprises become more and more blurred, and it was also the impression of the interviewer, that Infineon Austria regards itself as an Austrian enterprise, with Austrian management and a high degree of embeddedness in its local business environment.

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6.10 ELMOS

– Name of the company: Elmos Semiconductor AG, Dortmund, Germany
– Strategy, in short: Focus on Europe, Cultural differences matters

Description of the Company, Products:

ELMOS Semiconductor AG was founded in 1984 and is one of the leading developers and manufacturers of applications specific integrated circuits (ASICs) in analog/mixed signal CMOS technology. ELMOS manufactures special high-voltage circuits for automotive application. The integration possibilities of voltage regulators, analog/digital converters, micro-processor cores and many other options such as E^2PROM or FLASH storage offer a large range for customers' ideas. Additionally, ELMOS has competency in the field of sensors and assembly & packaging technology at its disposal.

The main departments are:
- Production (roughly 600 employees),
- R&D (roughly 220),
- Administration (roughly 80),
- Marketing and Sales (roughly 60), and
- Quality, facility management and IT (roughly 100).

Internationalisation Strategy:

Both the production site in Dortmund and all other departments in Dortmund (i.e., current number of employees at its headquarters roughly 690) grow continuously. More than a billion products and subsidiaries per year are produced in their own wafer fab located in Dortmund.

In 2001 ELMOS purchased two companies in California (currently roughly 100 employees) and in the Netherlands (currently roughly 180 employees). Elmos has increased its foreign sales quite significantly with the purchase of these companies. The production sites in the Netherlands and in the USA have grown in terms of employees. The activities (i.e., packaging of the chips and production of) have also increased.

Advantages of the production sites in Germany and the Netherlands include the close contact to the European automotive industry, good infrastructure, a fast administration, and optimal proximity to numerous universities.

At the beginning of 2005, a shift occurred from the German sales portion towards the other European countries (first France, Switzerland and Spain) due to changes in the supply chains of several major customers. Thus, the German share declined in comparison to the prior years, to 35.2 percent while the portion of the other EU countries gained, reaching 42.9 percent. The U.S. sales portion grew due to increased activity of ELMOS North America in selling ASICs on the North American market, amounting to 16.6 percent. So far, sales to Asia have been negligible.

The raw materials are mainly silicon wafers, chemicals for the circuit manufacturing and energy, as well as roughly half of the required assembly /packaging. Finally, Elmos makes use of design houses for services rendered. All this amounts to a material cost of roughly 39 million or 26 percent of sales. Assembly services are purchased in South-East Asia, and wafers and chemicals are mainly bought in Germany and Europe. Energy is sourced locally.

In the future, Elmos's in-house production is going to be limited to products with special requirements for design and technology. Therefore, components will be purchased if they cannot be manufactured with technologies offered by ELMOS more efficiently.

In addition to strategic partnerships, several semiconductor foundries, mainly located in Asia, accept commissions for production according to their own construction plans. Thanks to the technical capabilities of ELMOS Advanced Packaging, own and purchased components are going to be integrated into functional packages as multi-chip modules.

- Turnover 2005: Mio. EUR 147,0
- Profit 2005 (before tax): Mio. EUR 16,4 Euro:

Compiled by EIIW's Michael Vogelsang, Wuppertal

Sources: company's website, questionnaire, financial report & telephone interview.

6.11 Videoton

- Name of the company: Videoton, Szekesfehervar
- Strategy, in short: From an outsourcing provider to a full service engineering partner
- going east for labour intensive production.

Description of the Company, Products:

Videoton is a Contract Electronics Manufacturer (CEM) and the largest independent Electronics Manufacturing Services (EMS) provider in the CEE region, ranked in the TOP 30 worldwide and the TOP 10 in EU. Videoton gains outsourcing contracts, mainly from Western European countries, and produces, for example, fax-machines, TV sets, TV set-top boxes and different kinds of household appliances.

Videoton was established in 1938 and began producing black and white TV sets in 1959. After the change in the political system, the state-owned company lost its market. In 1991, three private investors and the ‘Magyar Hitel Bank Rt’ (Hungarian Credit Bank) acquired the assets of the company through a public competitive bidding process. Consumer electronics, informatics and the automotive industry became the main activities of the new company. In 1996, during the second phase of privatization, the bank sold its property to the management. In 1998, Videoton changed its strategy and started offering full contract solutions. In 1999, Videoton extended its activities outside of Hungary. Having acquired the DZU AD in Bulgaria, the company increased its manufacturing capacity.

Today Videoton provides complete end-to-end solutions for its customers in manufacturing and engineering services. It also offers value added services such as design, procurement, logistics, distribution, quality assurance, and project management. The company has more than 9,000 employees at 10 locations in 3 countries. Chines companies are the main competitors of Videoton.

Internationalisation Strategy:

Production is located in Hungary (8000 employees) and Bulgaria (1000 employees). A small office for marketing is located in Germany. An additional production plant in the Ukraine is planned.

The example of Videoton supports the hypothesis that labour intensive work shifts eastward. According to Videoton's management, Bulgaria has approximately 50 percent of the labour unit costs compared to Hungary. Labour in the Ukraine is even cheaper. China has 50-60 percent of the labour unit costs of Bulgaria. Products (e.g. cable loops) that were produced in Hungary ten years ago are now being produced in Bulgaria. Standard electronic components are imported from Asian companies.

On the other hand, the production process in Hungary has become more knowledge-intensive. Ten years ago all know-how was made available by the Western-European customers. Today Videoton deploys its own know-how. There are 150 employees working in the engineering department as compared to 0 (zero) in 1995. The next trend, according to Videoton's management, is that research and development will be outsourced by Western-European companies.

Overall, Videoton's management expect a threefold division of labour. West-Europe will specialize in design, development, marketing, and distribution, Middle-Europe (EU10) will specialize in engineering and development, and Eastern-European countries will specialize in labour-intensive production.

- Turnover 2003: 69 096 884 000 HUF
- Profit 2003: 10 657 663 000 HUF

Compiled by EIIW's Christian Schröder and Michael Vogelsang, Wuppertal Jan.-February. 2006

Sources: company's website, financial report & telephone interview

6.12 F-Secure

- Name of the company: F-Secure, Finland
- Strategy, in short: "Security as a Service"; Internationalisation step by step

Description of the Company, Products:

F-Secure Corporation protects individuals and businesses against computer viruses and other threats spreading through the Internet and mobile networks. Their products include antivirus, network encryption, desktop firewall with intrusion prevention, anti-spam and parental control. F-Secure's security solutions for enterprises offer scalable and centrally managed data security for corporations. A key selling proposition is the speed of response to new threats. F-Secure was founded in Helsinki, Finland, in 1988, and has been listed on the Helsinki Stock Exchange since 1999.

Internationalisation Strategy:

Internationalisation is carried out step by step. First trading and marketing partners are employed. If the market develops successfully, foreign offices or affiliates are established. Its main markets include European countries (80% of revenues), especially France, Germany and the UK. Additional high growth rates exist in East-European markets, especially Poland. A new target is Asia. The good reputation of high-technology products from Finland (Nokia) helps internationalizing. Business with USA is weak, due to cultural differences. F-Secure has based its Headquarters in Helsinki, with offices existing throughout the world in USA, France, Germany, Italy, Sweden, Norway, Poland, UK, Japan and Singapore. Supported by several regional resellers and distributors, F-Secure's products are now offered and supported in over 50 countries.

Research & Development is only located in Helsinki, however, 'virus watch laboratories' are working in San Jose, USA, and Singapore. Three to four 'virus watchers' are employed in these ‘virus watch laboratories’ as compared to almost 150 researchers in Helsinki. The ability to watch the spread of new viruses along all time-zones and regions, and provid local support to large customers, are the advantages associated with locating 'virus watch laboratories' internationally.

Delivery of Products:

In the beginning, F-Secure sold its products via Internet (download) and on CD (box-Solution). Since 2004 the strategy changed to bundle Anti-Virus solutions with additional services which require a local presence in international markets. The new strategy is called "security as a service". Additional services include, for example, consulting in network, security and organizational concepts and gateway solutions. Two strategic customers are mainly focussed on large companies, and Internet Service Providers (ISPs), as direct customers and resellers or licensees. Other service providers, e.g. software development companies, join a partner program to offer consulting and implementation of the software to B2B customers.

Today B2C products for home-users and small offices without IT staff, only amount to 25% of total revenues. These products are easy-to-purchase, easy-to-use automated security services for both PCs and mobile terminals. Providers offering internet access, communication and email services are the most important licensees for these services, for example Nokia (mobiles), T-Online (internet access) and Web.de (email service). Depending on the contract, licensees can offer F-Secure's products in their own look and feel. Final customers can buy internet protection as an online service (WebService) or as a desktop solution (download or CD) including online updates.

Today, only 15% of F-Secure's products (B2B and B2C) are delivered on CD.

- Turnover 2004: 47.268.000 €
- Profit 2004: 13.404.000 €

Compiled by EIIW's Christian Schröder and Michael Vogelsang, Wuppertal Jan. 2006

Sources: company's website, financial report & telephone interview.

6.13 T-Systems (by Paul Welfens)

Introduction

T-Systems is a 100% subsidiary of Deutsche Telekom AG, one of the world's leading providers of information and communications technology services, setting international standards, with annual revenues of about 60 billion Euros. T-Systems is one of Europe's leading providers of information and communications technology (ICT). Within the Deutsche Telekom Group, T-Systems serves business customers. The company has 52,000 employees in over 20 countries worldwide, and posted revenues of approximately €12.9 billion in 2005. On April 1, 2006, T-Systems took over the shares in gedas AG from Volkswagen AG. gedas generated a turnover of around 606 million euros in 2005 and serves customers in the industry sectors for automotive, transport, logistics and public administration.

Companies across practically all industries face similar challenges: increasingly saturated markets, the increasing similarity of products and services, aggressive price competition and the rapid pace of change. These challenges mean that companies have to focus on two key strategies if they are to ensure long-term success: an effective, customer-driven business model, and efficient, effective business processes that ensure high flexibility in all areas. T-Systems optimizes processes and cuts costs for its customers, giving them greater flexibility for their core business. Services span the entire ICT value chain – from infrastructure and solutions to business-process outsourcing.

In this challenging, burgeoning market, T-Systems is responsible for operations with approximately 60 multinational corporations and major public-sector organizations, as well as 160,000 large and mid-size customers.

T-Systems is one of the Europe's leading ICT providers – the company offers:

- Business process management – operation and administration of complete processes on the customer's behalf;
- Business solution design & implementation – development, implementation and operation of solutions that support the customer's processes; and
- ICT infrastructure management – infrastructure for multiple processes available at low cost.

T-Systems works with many international customers and has put into place global corporate networks and digital communication solutions in the fields of Internet Protocol, business voice, data communications and carriers solutions. With respect to information technology, T-Systems offers worldwide IT services in the fields of systems integration, computing services and desktop services. The company has a broad approach as it optimizes, integrates and operates systems, infrastructures, data processing systems and applications. The convergence of data, video, audio and voice telephony, represents crucial opportunities and challenges for large companies and SMEs active in international markets, hence T-Systems caters to growing needs of modern companies.

T-Systems offers five core services:

- Consulting,
- Desktop Services,
- Computing Services,
- System Integration, and
- Network Services.

Deutsche Telekom is certainly one of the most important customers of T-Systems. As Deutsche Telekom expands internationally, the international business opportunities for T-Systems also grow. However, if Deutsche Telekom pulls out of certain markets, the internationalisation dynamics of T-Systems are slowed down.

The sectors covered by T-Systems concern:

- Aerospace & Defense,
- Automotive,
- Broadcasting,
- Chemicals,
- Education & Research,
- Electrical, Plant & Mechanical Engineering,
- Financial Services & Banking,
- Healthcare,
- Insurance,
- Public Sector,
- Travel & Transportation,
- Retail,
- Telecommunications, and
- Service Sector.

T-Systems is expected to benefit from the triple play approach of Deutsche Telekom, namely the provision of voice telephone, internet and TV in Germany and other EU countries. Deutsche Telekom has reinforced its position in Poland and Austria – in the latter through the expansion of mobile telecommunications.

T-Systems has been part of the Toll Collect consortium in Germany which has developed a GPS-based road toll system (basically applied to trucks on German highways) which is expected to be exported to many countries where there is a need to organize traffic more efficiently. There are several public private partnership projects where T-Systems has been successful.

T-Systems is also active in education and research as the company offers solutions for modernizing ICT infrastructure. The subsidiary T-Systems Solutions for Research GmbH (SfR) was established in 1999, namely as a joint venture between T-Systems International (75%) and DLR, the German Aerospace Center (25%). Customers include DLR, the German Weather Service, the University of Stuttgart, the German Association for Plant and Reactor Safety (GRS), and the German Research Foundation/DFG.

T-Systems is active in Austria, Belgium, Brazil, Canada, China/Hong Kong, Czech Republic, Denmark, France, Germany, Hungary, Italy, Japan, Netherlands, Poland, Russia, Singapore, South Africa, Spain, Sweden, Switzerland, Turkey, UK, and the USA.

On April 1, 2006, T-Systems took over the shares in gedas AG from Volkswagen AG. gedas generated a turnover of around 606 million euros in 2005 and serves customers in the industry sectors for automotive, transport, logistics, and public administration. The integration of gedas will be completed in 2007.

The acquisition of gedas should help T-Systems in three ways:

- Expansion into new countries,
- Reinforcing existing IT services solutions for the automotive industry, and
- Gaining critical size in terms of international service provision.

While it is too early to assess the exact contribution of gedas for T-Systems, it is clear that this acquisition has a strong potential for growth and internationalisation.

International Expansion of T-Systems Activities

International expansion of T-Systems has occurred in parallel to the internationalisation of Deutsche Telekom. While some activities abroad date back to the 1980s a strong expansion of international business has taken place in the 1990s. The worldwide growth of narrow-band and broadband digital networks has certainly facilitated the provision of IT services across borders, but it also has reinforced the global demand for advanced IT services.

In 2006, the international expansion of T-Systems has been boosted by the acquisition of gedas in April 2006, which by 2007 will become fully integrated into T-Systems. For more than two decades gedas, the IT subsidiary of Volkswagen, has been a strong player in the automotive market in both North and Latin America, and in Asia. In 2005 revenue, achieved on the basis of 5,500 employees, was about € 600 million. The company gedas offers not only services for the automotive industry, but also for clients in the manufacturing industry, transport and logistics, as well as the public sector. T-Systems consider gedas as an important element in its internationalisation strategy; especially since its customers include BMW, DaimlerChrysler, Ford and VW. Considering the subsidiaries of VW in Europe, namely SEAT and VW company-owned production facilities in Spain and Portugal, T-Systems will be strengthened in the Iberian peninsula. Moreover, gedas is active in Argentina, Brazil, China, Czech Republic, France, Germany, Japan, Mexico, Portugal, Spain, UK and USA, so that gedas reinforces and broadens the internationalisation of T- Systems. In terms of countries, the acquisition of gedas brings additional presence in Argentina, China, Mexico and Portugal.

The fact that automotive firms in the USA, Europe and Japan have increasingly realized various outsourcing options in the two decades after 1985, indicates that focus on core competences in the automotive industry has become more important and that ICT outsourcing is gaining importance. This creates an attractive field of expansion for IT service providers active in international markets.

For many years, gedas not only focussed its IT services in Germany, but in Latin America (Brazil and Mexico), Asia (China) and several EU countries, where there were also major activities. Given that gedas has been active in a rather competitive international environment, one may anticipate that integration of gedas will strengthen the internationalisation of T-Systems.

Motives for Internationalisation

Given EU eastern enlargement and sustained globalization, it is clear that T-Systems faces new opportunities abroad as many of its German industry customers and customers of the service sector are expanding internationally. T-Systems has its main activities in Europe and North America, while expansion into Asia has been rather hesitant. Only with the recent acquisition of gedas, has T-Systems established a broader presence in Asia where China can be expected to play a major role in the future. To some extent it is surprising that T-Systems has not entered the market in India, however, as German-Indian economic relations are expanding one may anticipate that T-Systems will become more active in India and Asia, respectively.

T-Systems cooperates with many universities and research centers. Moreover, it has also launched an international university which is basically a big international conference organized in cooperation with a university or a major research center. As this international university workshop takes place in various countries (in 2006 in Germany, in 2007 in Switzerland) and also invites European universities to a competitive bidding to become a partner for this event, it is clear the T-Systems strives for a broader international profile. With Deutsche Telekom, the parent company providing a solid stream of revenues and earnings, respectively, T-Systems is able to embark on broad international projects and finance international mergers and acquisitions. At the same time it is true that with Deutsche Telekom facing increasing competition in telecommunications markets, and hence a profit squeeze and the need to further cut costs, T-Systems will face stronger pressure to come up with services innovations and lower intra-company prices in the future.

With mobile telecommunications markets rapidly expanding in North-America, Europe and Asia, one may anticipate that T-Systems will enjoy particular opportunities for expanding in digital markets characterized by digital convergence. With increasing mobile-fixed network substitution worldwide, T-Systems is expected to benefit from new business opportunities Given the extent that the Toll Collect consortium will be able to export its approach to road charging, it is apparent that T-Systems should also benefit strongly. The growing number of private public partnership projects in OECD countries and some Newly Industrializing Countries also supports new opportunities. However, T-Systems might face two major problems in internationalisation:

- The company covers a wide range of sectors which require rather specific solutions. It is not clear that T-Systems can roll out in very competitive markets, their own solutions for a broad range of sectors, however, T-Systems has recognized some of the problems mentioned and reinforced cooperation with major players, including SAP in some fields.
- T-Systems is not strongly present in Asian countries which could offer valuable opportunities for outsourcing parts of software development, important options for a company in need of cutting costs. Moreover, Asian economic dynamics are strong enough to make Asia a key region for a global IT company. With the opening-up of telecommunications markets in Asia and Latin America, T-Systems is likely to find new markets in the future.

As is emphasized in Welfens/Weske (2006), software development can be outsourced internationally to some extent where reliance of subsidiaries is important as it means to protect intellectual property rights. However, the international outsourcing concerns only relatively unsophisticated standardized programming elements, so that the high value-added of IT services is likely to remain in the EU as European IT houses intensify international outsourcing of software programming.

Summary

T-Systems has a solid domestic and European market which generates sustained revenues and profits, however, it is also facing tough competition from other international IT companies. The company has a broad array of sectors in which it is active. It has shown strong performance in

- Telecommunications,
- Automotive sector (after acquisition of Gedas in April 2006),
- Public sector, and
- Transportation – assuming that the initial problems with the innovative Toll Collect system are over.

Such strengths are complemented by other sectors which are less developed but hold some potential for the future.

The expansion to the USA and Canada has been motivated by three motives:

- Support for German firms active in North America;
- Developing new lines of business around mobile telecommunications in the USwhere Deutsche Telekom’s acquisition of Voice Stream has created a new field of expansion; and,

- Exploiting the dynamics of the advanced North-American market where advanced technologies and new business models can be studied.

T-Systems has considerable autonomy within Deutsche Telekom AG but is also under pressure to achieve higher profitability. As a knowledge intensive service provider in a highly dynamic market, T-Systems is facing the challenge to establish market leadership in Europe and to generate more revenues in North America and Asia in the future.

The acquisition of gedas has reinforced the internationalisation process of T-Systems. T-Systems now has a seven year IT services contract with Volkswagen. The long term growth of the global automotive industry should generate future impulses for internationalisation.

However, as the IT market is increasingly competitive, T-Systems is facing serious challenges in raising its profitability and in expanding in the growing Asian market. Given the fact that Deutsche Telekom AG is its parent company, it has a strong financial background. Moreover, T-Systems has been rather successful in various private public partnerships and might benefit internationally if such PPPs should expand in OECD countries and elsewhere.

IT offshoring will become increasingly important in the field of PPPs as governments, e.g. in Asia and Latin America, are rather unwilling to cooperate with firms which are not active employers in the respective country. With the creation of an international university, T-Systems has embarked upon a new project, which brings together major customers from many countries and thus stimulates international networking and international diffusion.

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