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Leonid Grinin
Andrey Korotayev

Great Divergence and Great Convergence

A Global Perspective

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Great Divergence and Great Convergence

A Global Perspective

With a Foreword by Jack A. Goldstone

Springer

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Foreword

Since man first forged metal tools and started farming for his food, thus emerging from the stone age, no event in human history has had a greater impact than the Industrial Revolution of the eighteenth and nineteenth centuries. During that span, Europeans increased their use of fossil fuel energy by several orders of magnitude, began to use that fossil fuel energy to produce motive power as well as heat, and developed a host of high-efficiency industrial processes and new modes of transportation, with spillovers into military technology as well. As a result, Europeans went from "underdeveloped" nations, who mainly traded raw materials and bullion for the manufactured and plantation goods of the "developed" world of Asia (cotton and silk textiles; ceramics and lacquer ware and tropical woods; coffee, tea, indigo, nuts, and spices), and who were allowed limited trading roles on the suffrage of India, China, and Japan, to the world's center of manufacturing and manufactured exports, with military dominance and the ability to dictate terms of trade to the major Asian societies.

The shorthand summary of this process for the last two centuries has been the "Rise of the West" and explaining it has been one of the central questions of the social sciences. The traditional view since the time of Karl Marx and Max Weber, extended by twentieth century scholars such as William McNeil (1963, 1990) and David Landes (1998), was that since the middle ages, Europe was a uniquely creative society that advanced in agriculture, accounting, use of wind and water power, and craftsmanship, while Asian societies reached their peak of development in the medieval period, and thereafter simply maintained themselves in a kind of "frozen" state of development or even declined. While in the medieval period the societies of Abbasid Islam and Song China might have started at a higher level of economic productivity and technology than Europe, the "rise" of European productivity and technology over the succeeding centuries led to European global domination by the nineteenth century.

Yet in the last two decades, a group of comparative sociologists and global historians have offered a counter-narrative, led by scholars of the "California School" of global historians (Goldstone 1991, 2002, 2008a, b; Pomeranz 2000, 2002; Wong 1997; Frank 1998; Marks 2002; Vries 2003, 2010). This counter-narrative called

attention to the continuing vitality of agricultural and manufacturing technology in Asia, with India and China remaining world-dominant manufacturing powers up through the seventeenth century. It illustrated relatively high living standards among the Asian agricultural population, comparable to those in Europe, up to 1800. And it demonstrated that Asian merchants and pirates were the equal or superior of European trading companies in wealth and military prowess until the late 1700s. In this counter-narrative, the dominant position of Europe arose rather quickly, not as a long "rise" but as a sudden "Great Divergence" from roughly equal levels of productivity and material well-being c. 1750 to clear European dominance a century later.

Both the traditional view and the California school view prompted similar questions: What caused Europe to reach clear superiority in wealth and power c. 1850? And is this superiority destined to last a long time, or will it disappear as quickly as it arrived? Yet they provided very different answers. The traditional view sought to explain a long-term rise by deep and lasting features of European societies—their religious pluralism and heterodoxy (especially Puritanism and Calvinism), their heritage of Greek democracy and science and Roman law, the competitive multistate system in which they were embedded, regimes of secure property rights and superior accounting of profit and loss, more advanced systems of credit provision, much higher levels of wages achieved by urban workers, and long-lasting experience in transnational and transcontinental trade. From all of these, military superiority and accelerating productivity growth naturally emerged. Yet since it took many centuries for this pattern of modern industrial economic growth to be established, rooted in unique and characteristically European institutions and cultures, it would take a very long time (if ever) for non-European societies to converge in income and productivity levels with the West.

The California School takes the opposite view. Since the divergence was late and rapid, they emphasize advantages that appeared late and somewhat by chance: the discoveries that American colonies could produce bountiful cheap cotton for European industry, and that England's abundant coal could be used to fuel piston and rotary engines; the sudden eighteenth century breakthroughs in mechanical engines and production techniques by British metalworkers and craftsmen; and the internal conflicts that undermined the efficiency of Chinese, Ottoman, and Indian agriculture and crafts and governance, amplified by European military aggression. For many of the California School, since the surge of European dominance was short and based more on recent acquisitions and discoveries than long-lasting and unique characteristics, there was every reason to expect that non-European countries would quickly catch up. The success of Japan and South Korea in reaching Western levels of technology and living standards, and the recent growth of China and India at much faster rates than Western nations, suggests that this viewpoint is a more accurate template of current conditions.

For the last decade, proponents of the traditional view and the California school have argued, producing more details and additional arguments to buttress their case. But neither side has won the argument—instead the weaknesses of both positions now stand revealed. On the one hand, many assumptions of the traditional view, that

Europe was superior in military technology, trading acumen, and scientific advances as early as the 1500s or earlier, have been shown to be unfounded (cf. Agoston 2008; Andrade 2015; Ragep and Feldhay 2015). On the other hand, many assumptions of the California School, especially that the most advanced regions of China had incomes per head equal to those in the most advanced regions of Europe as late as 1800, have been called into doubt (Allen et al. 2011; Li and van Zanden 2012). As a result, the era from 1500 to 1800 has emerged as central. Yet our view of those centuries remains cloudy: Of the many characteristics and circumstances that separated European societies from Asian ones in these centuries, which were critical for the later emergence of European domination after 1800?

Into this confusion, Leonid Grinin and Andrey Korotayev bring clarity and order. They treat the period from 1450 to 1830 as a lengthy period of innovation and productivity increase in Europe, starting from a relatively low level of inventive activity and technology, but proceeding through a series of phases, of which the last phase—from 1760 to 1830, constituting the "classic" Industrial Revolution—was only the final phase of a lengthy process. These phases began with a "preparatory" period from 1100 to 1450 in which the development of free labor and capitalist relations set the stage for profit-seeking and further economic developments, peaking in the rich luxury manufactures of Venice and the trade and accounting and artistic and scientific breakthroughs of the Renaissance. Then the "long sixteenth century" from the late fifteenth to the early seventeenth century showed remarkable advances in oceanic navigation, engineering, windmills and water power, and commercialized high productivity agriculture, led by the Portuguese and Spanish, but also Germany and the Netherlands. This was also the age of the great discoveries and the early breakthroughs to the mechanical model of nature in European sciences. After this period, the next phase arose from the early seventeenth century through the third quarter of the eighteenth century, led by advances in Britain and especially the Netherlands. This period saw the consolidation of constitutional monarchy in Britain and of oligarchic republican rule in the Netherlands; the latter's development of mechanization, fishing, warehousing, and complex industrial centers; and the rise of global trading companies and military advances, especially in naval warfare. All of these prior developments then set the stage for the "final phase" of the Industrial Revolution utilizing fossil-fuel and water-powered machinery and major advances in chemical processes and transport as well.

This new view, carefully presented and rigorously modeled by Grinin and Korotayev, provides a richer and more nuanced version of the "Great Divergence," bridging many of the differences between the traditional and California viewpoints. Yet they go further. Amazingly, by building a model utilizing human capital (education), global population growth, and regional productivity, they show how both the Great Divergence and the recent "Great Convergence" (the economic catching up of developing countries) are phases of the same process of global modernization. They make it clear that once begun, the Great Divergence inevitably leads to later Convergence through the globalization of the world economy. Yet they also explain specific regional lags and variations in this process.

This is a remarkable achievement and a major advance in the debate on the long-term trajectory of global economic development. The Russian global-historical systems school of scholarship has long been making important contributions to identifying and explaining the major patterns in long-term world history (Turchin and Korotayev 2006; Turchin and Nefedov 2009; Korotayev et al. 2006a, b; Korotayev and Tsirel 2010; Grinin 2007, 2011a, 2012a; Grinin and Korotayev 2006). It is a pleasure to introduce this latest work to a broader audience, and commend it to all those who are interested in the debate on the rise of the west and Great Divergence, and all who ponder the future of global inequality and development.

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Chapter 1
Introduction. And Yet the Twain Meet: Great Convergence Brings the East Closer to the West

Why This Book Has Been Written, or the Great Divergence and Great Convergence as Two Phases of a Single Process

The globalizing world needs global knowledge that is required to investigate global processes. This monograph is devoted to the analysis of such truly global processes. It considers the economic development of the world in the last 600 years and offers forecasts for the next five decades and more.

The nineteenth century witnessed an explosive growth of a gap in per capita incomes (and the level of development in general) between the West and the rest of the world that has become recently known as *"the Great Divergence"*. In the twentieth century, the Great Divergence continued until the early 1970s; then, in the late 1980s, some convergence between the First and Third World started to be observed. Though this convergence has been noticed already by a number of researchers, many economists still doubt its presence or importance.

In this book we demonstrate that after the 1980s we deal with a global process of the same scale as the process of the Great Divergence and we propose to designate it as the *"the Great Convergence"*. Furthermore we show that the Great Convergence is a logical continuation of the Great Divergence, and that certain components of the Great Divergence process were already preparing the onset of the Great Convergence in the period of the former's peak. What is more, we suggest that the Great Divergence and Great Convergence constitute two phases of a single Global Modernization process being tightly intertwined with other dimensions of Global Modernization as well as with globalization in all its historical phases.

We also provide some evidence in support of our forecast that the process of the Great Convergence will continue over the forthcoming decades and, thus, will be one of the main factors in our globalizing world.

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How Did the Perception by the Europeans of the Non-European World Change? From Marco Polo to the California School

It has long been known that societies develop unevenly. In fact, we are dealing with a kind of law of uneven development of societies, which implies that from time to time the leaders of global development (as well as the ideas about the balance of forces in the world) change. At the same time, certain ideas about the world hierarchy (after they have been strengthening for quite some time) can become very strong stereotypes even among historians and economists who seemingly should have a deeper understanding of how quickly things may change. And it is rather symptomatic that the strongest belief in such stereotypes appear just before the reversal of the respective trends (that can turn rather unexpected indeed). This phenomenon, by the way, is one of the reasons of the abovementioned underestimation of the importance of the present-day convergence.

Since the thirteenth century (especially after the famous book *The Travels of Marco Polo* had appeared) for several centuries the Europeans perceived the Orient to be fabulously rich in comparison with their own countries, and the quality of products manufactured by the Eastern masters seemed unattainable. But then, already in the eighteenth century (Gordon 1997; Alam 2006) such perceptions began to change rapidly. Now the Orient, by contrast, became synonymous with a sort of eternal stagnation and backwardness.

In the nineteenth century, Europe (and the West in general) left Asia and North Africa (let alone Sub-Saharan Africa) far behind as regards their level of development in economic, military, scientific, educational, and many other spheres. Britain and other Western countries, to varying degrees of completeness, subjugated most Asian and African societies. The Western influence was crucial for the rest of the world and very noticeable in economic terms even in the distant periphery of the eastern states. The fact is that the increased industrial might of Europe turned Asian countries first into markets for European manufactured goods and then ruined Asian artisans, and finally transformed "the Orient" into a place for the application of European capital and a source of cheap labor.

This very wide socioeconomic gap (whose emergence was much later called "the Great Divergence") between Europe and Asia became a fact that did not require proof; it was so evident that there was an idea that this superiority was something perfectly natural and permanent, in other words, "a simple affair" (Goldstone 2013: 54). One could observe the strengthening of the idea (that emerged in the eighteenth century) of the stagnant Orient that supposedly had never developed, of the Orient which had constant primordial essential features, including "its tendency to despotism, its aberrant mentality, its habits of inaccuracy, its backwardness" (Said 1979: 205). The West was supposed to be so different from the East that they had little in common. Finally, such a view was crystallized in the poetic words of Rudyard Kipling "*East is East and West is West, and never the twain shall meet*" (Kipling 1919: 3). On the one hand, this approach led to the situation when "every European,

in what he could say about the Orient", risked to appear as "a racist, an imperialist, and almost totally ethnocentric" (Said 1979: 204). On the other hand, such views led to the birth of the theory of civilizations (Rückert 1857; Данилевский 1995 [1869]; Spengler 1991 [1918–1922]; Toynbee [1934–1961], etc.), as unique incomparable cultures.[1] But in any case, the backwardness of the East and the superiority of the West were perceived almost as natural things that could be explained from different philosophical perspectives (including even racist ones), but the reasons for the rise of the West and the retardation of the East were not among the principal issues discussed by the social scientists of the time of the Great Divergence. Perhaps, this view was fundamentally important only for schools, which saw the historical process as a single line, or from the position of a single main factor, as this was observed within the framework of unilinear evolutionism (see, e.g., Carneiro 2003), or the geographic school or Marxism.[2]

Overall it is not, therefore, surprising that until the second half of the twentieth century the problem of correlation in the development of the East and the West was not investigated adequately. In the second half of the twentieth century together with the liberation of the colonies and the generally increasing importance of developing countries, this issue became more popular, and it began to be studied from different points of view.

In the early 1960s the famous book by William McNeill (1963) *The Rise of the West* came out; it had a characteristic subtitle *A History of the Human Community*, which seemed to suggest that the achievements of the West for some time now became synonymous with the achievements of humankind. And although the book actually paid much attention to the history of non-Western civilizations, the author seems to have taken the dominance of the West for granted, which is reflected in particular in the fact that in 1963 McNeill did not recognize the leading role of China and the Chinese civilization in the period between 1000 and 1500. Later, having reconsidered his approach, McNeil quite frankly acknowledged this fault (McNeill 1990: 5), as well as the pressure of Eurocentric stereotypes in general:

> "In retrospect it seems obvious that *The Rise of the West* should be seen as an expression of the postwar imperial mood in the United States. Its scope and conception is a form of intellectual imperialism, for it takes on the world as a whole, and it tries to understand global history on the basis of cultural diffusion developed among American anthropologists in the 1930s" (McNeill 1990: 1–2).

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[1] On this basis Spengler, however, expressed an idea (that seemed pretty seditious in 1918) that the success of the West was not eternal and that (like any other culture that experienced its transformation into civilization) it was to expect its "sunset" in the forthcoming centuries. Incidentally, Spengler suggested the turn in the century (around 2000) as a landmark around which he expected the start of the acute phase of the crisis of the Western culture.

[2] Incidentally, this point was one of the main reason why the problem of the comparison of the development of the East and the West was so important for the Soviet historians and theorists (e.g., Семенов 1970, 1980; Качановский 1971; Васильев 1988; Фурсов 1989; Нуреев 1989; for the analysis of the study of this issue among the Soviet social scientists see, e.g., Gellner 1988; Гринин 1998; Korotayev et al. 2000: 24–25) many of whom achieved quite interesting results (*e.g.*, Сказкин et al. 1962; Никифоров 1977; Павлов 1979; Васильев 1982).

In the 1970s and 1980s many interesting works on the economic history of Asian countries were published, and many of them consisted of valuable comparisons between Asia and Europe, including economic development of the East within global development. Some of these works have become the classics (e.g., Braudel 1973; Bairoch 1975; Issawi 1980; Maddison 1983; Cameron 1989). One could observe the transition to truly scientific (and at the same time historical) methods in these and many other works, because these problems (i.e., the question of the causes of the East lagging behind the West) were placed at the center of research in economic and demographic history with the appropriate use of quantitative methods. In fact, it is very difficult to compare different cultures and cultural codes, especially if one insists on their uniqueness and incomparability. However, it is possible to compare indicators such as fertility and mortality rates, GDP per capita or calorie intake per capita, and yield and productivity. Here we unquestionably see a clear common denominator which may help to perform a cross-national study of the economic and social history of all societies. Thus, there was a return to the idea of scientific approaches and common laws of historical development of different societies on a new basis. A particularly important contribution to the scientific study of the Great Divergence was made by the California School that formed in the late 1990s and the early 2000s (Blaut 1993, 2000; Goody 1996, 2004; Wong 1997; Frank 1998; Lee and Wang 1999; Lieberman 1999, 2003; Pomeranz 2000, 2002; Goldstone 1991, 2000, 2002, 2009a, 2013; Hobson 2004; Rosenthal and Wong 2011; Vries 2013). Note that the very term "Great Divergence" appeared in the writings of scholars of this particular school. The founder of this school, Jack Goldstone quite justly maintains:

> "The problem of the Rise of the West has become ever-greater and more complex in the last two decades. The 'California School' scholars (including myself) have documented deep parallels between the material and political dynamics of European and Asian societies up through the early nineteenth century. We find that in many respects… the growing quantitative record of economic history shows that Europeans were laggards, not leaders, in many areas… Given this clear lead of Asian societies in exploration, production, manufacturing, seafaring and navigation, experimental science, pluralism and toleration, lasting well into the seventeenth and in some respects the eighteenth century, it has become far more difficult to explain how and why Europeans suddenly leapt forward, becoming by the nineteenth century masters of the world in all of these respects. From a region that in the twelfth, thirteenth, fourteenth, and fifteenth centuries was pushed back on its heels by the Arabs, the Mongols and the Turks, Europe suddenly became the aggressor, driving into Asia and becoming the victor and conqueror. Because this change was relatively sudden and relatively late, what is now labeled the 'Great Divergence' of East and West (Pomeranz 2000) has become very difficult to explain, and attracted a range of increasingly diverse and even wild theories. What was once easy to explain in terms of long-standing, deep-rooted, and persistent European advantages now is much harder to explain, as a sudden and late reversal in global fortunes" (Goldstone 2013: 55–56).

The California School has made a very important contribution in its attempt to reconstruct the real proportions of the scales and levels of development of various societies in the Early Modern Period. This allows us to remove distortions in our understanding and imbalances of the Eurocentric view of history. In this respect one can compare them with the creators of the civilizational approach, which opened

civilizations to the Europeans, showing these civilizations to be comparable and even superior to the European civilization. To our mind, the most important contribution of the California School is that its studies have demonstrated in a very convincing way that the general level of the development of the most advanced societies of the East was in the Early Modern Period quite comparable with that of the Early Modern European societies.[3]

But still we should note that some general theoretical approaches of a number of representatives of this school have significant methodological flaws that eventually exaggerate the abruptness of the Western breakthrough and that these flaws do not allow us to understand that the process of divergence in a number of important aspects began much earlier than the nineteenth century (this point is discussed in detail in Chap. 2 of this monograph).[4]

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[3] On the other hand, the authors of the present monograph having obtained their majors in History in Soviet universities had a feeling of *déjà vu* when they started reading the studies produced by the California School. Indeed, this was just what the orthodox Soviet Marxist professors and orthodox Soviet Marxist textbooks used to teach (*e.g.*, Симоновская and Ацамба 1968; Губер et al. 1982; Ацамба et al. 1989). These were rather a very few dissident Soviet Marxists who relied on Marx' notion of the "Asiatic mode of production" and insisted on the point that Medieval and Early Modern East lagged far behind Medieval and Early Modern West (Семенов 1970, 1980; Васильев 1982, 1988; Фурсов 1989; Нуреев 1989). The orthodox Soviet Marxists insisted that in the Middle Ages both the advanced societies of the East and the advanced societies of West belonged to one ("feudal") "socioeconomic formation" and, hence, they had an essentially similar level of development. According to them, in the Early Modern Period the most advanced Eastern societies somehow lagged behind the most advanced Western societies as regards the development of capitalism, but before the nineteenth century the lead of the West was not significant; it only became really significant in the nineteenth century in direct relations with colonial/semi-colonial subjugation of the East by the West. The data on the discussion on the Asiatic mode of production in the Soviet Union (1928–1931) presented by Nikiforov (Никифоров 1977: 176–186) demonstrate that the Communist Leadership of the Soviet Union and Comintern opted for the theory of "Eastern Feudalism" rather than "Asiatic mode of production" mainly for political reasons, as the latter theory implied that the East lagged too much behind the West and, hence, one would have to wait too long before the former caught up with the latter—thus opening perspectives of the Communist revolution (which, according to Marx demanded a substantially high level of development of capitalist relationships). However, the Soviet orthodox Marxist scholars did not limit themselves to ideological declarations but presented substantial evidence demonstrating that in the Late Middle Ages and the Early Modern Period the most advanced societies of the East had approximately the same level of development as the European societies (though they recognized that by the early nineteenth century the former were somehow lagging behind the latter as regards the development of capitalist relations) (*e.g.*, Сказкин и др. 1962; Качановский 1971; Никифоров 1977).

[4] About the achievements, development and some difficulties in the course of researches of California School see also in the Preface to this monograph written by Jack Goldstone. Here we would mention only the fact that the representatives of this school tend to underestimate a fundamental point that the great breakthrough toward the use of machines and steam power (that was observed in the second half of the eighteenth century in Britain) was a result of a rather long-term pan-European scientific and technological development. For example, the idea of some representatives of the California School and some economists who are ideologically close to it (like Robert Allen) that the main causes of the industrial revolution in Britain were coals and colonies (Pomeranz 2000; Allen 2009, 2011), does not take into account the point that all of these benefits (or the possibility of their use) in itself are already the result of socio-economic peculiarities of Europe. Thus, commerce developed in Europe for several centuries (and it received a substantial additional push

Great Convergence in the Past and in the Future

Even the largest-scale processes have their beginnings and their ends, they cannot be eternal. Moreover, many processes are not just terminated; they may well be transformed into their opposites. In fact, this was just the case of the Great Divergence. Those processes that switched the Great Divergence into the Great Convergence were gaining momentum gradually, almost imperceptibly. By now the fact of the growing convergence between the First and the Third world has been noticed by a number of researchers (e.g., Amsden 2004; Sala-i-Martin 2006; Мельянцев 2009; Spence 2011; Derviş 2012). However, in our view, even these researchers underestimate the real scale and historical significance of this process. As we have already mentioned previously, in the present monograph we demonstrate that after the 1980s we deal with the Great Convergence, that is with a global process of the same scale as the process of the Great Divergence.

A very interesting point (treated in detail in Chap. 4) is that the Western societies fertilized (sometimes against their will) the soil for the onset of the Great Convergence. The reason is that in order to maintain its superiority (and, thus, to support the Great Divergence) the West had in one form or another to introduce in the East modern infrastructure, education, management and so on. First, of course, Britain and other European countries were concerned with the opening of Asian markets for their manufactured goods, which involved a rather active use of various military and financial means. However, they discovered very soon that to continue the expansion of exports of goods they needed to improve the infrastructure in the peripheral countries and to modernize certain sectors of these countries. That is why the process of opening and expanding markets almost immediately started to require the export of capital in general and massive investments in infrastructure in particular, as well as in the expansion of the production of raw materials in the countries of the World System periphery. The Western technology began to penetrate the East. This was the beginning of the conversion with the looming perspective of

from the Reformation and the diffusion of the book-printing); the ability to establish and maintain colonies was the result of amplification of naval and military-technical superiority of the Europeans; whereas before the coal became a new industrial energy source, it would take many decades of technical and scientific breakthroughs. The point that some of the California School representatives tend to ignore that by the late eighteenth century the West was much more developed than the East in some quite important respects is connected with their tendency to exaggerate the degree of similarity of the development of China and Europe, even by the end of the eighteenth century, based on the comparison of a very few (though, still, quite important) indicators (such as real wage or per capita calorie intakes). Such comparisons do not take into account a number of other dimensions where Europe overtook the East already in the Early Modern Period (like the science and technology development rates, military organization, or development of financial systems). The fact is that the overall level of development is measured rather imperfectly with the level of societies' wealth or per capita incomes. In the present-day world this point is well illustrated by some oil-exporting states whose per capita incomes are often quite comparable with the ones of many advanced Western states, whereas the overall level of development of the latter is still much higher than the one of the former.

Convergence. In general, this contributed significantly to the development of local industry and economy and the growth of national consciousness.

In recent decades, this was the struggle of the West for the free movement of its capital and goods that eventually led to a new and much more powerful wave of economic globalization, a wave through which de-industrialization of the West and industrialization in the East began—respectively, the growth rates in the West fell, and in the East, they rose. This observation is not trivial. In fact, one of the main accusations directed toward globalization is that it deepens the gap between the developed and developing countries dooming the latter to eternal backwardness. This quite common belief obscures the true picture of the world.

In the present monograph we demonstrate that the actual situation is quite the opposite. Our studies show that it is due to the globalization that the developing countries are generally growing much faster than the developed states, as this happens, the World System core is beginning to weaken and its periphery is beginning to strengthen. In the third chapter of the book we provide substantial data to prove this idea. In the fourth chapter we explain why the globalization was bound to lead to the explosive rise of many developing countries and the relative weakening of the developed economies.

The Great Divergence is not just a process of growing differences in the levels of development of the West and the Rest, but also the process of the emergence of a new type of global economic system in which the economies of various countries were incorporated into a single world economic system (but with very different roles). Similarly, the Great Convergence is changing the World System and nations' roles within it due to the new opportunities of the global division of labor.

But the Great Convergence has not only a purely economic, but also a technological basis, as it has accelerated as a result of the information revolution that facilitated the movement of capital, information and the use of remote workforce and educational resources. Thus, what caused the Great Divergence? The Industrial Revolution did. What triggered the Great Convergence of our time? It was the Information Revolution (that radically accelerated globalization processes).

Since the 1950s, economists [first of all, Gerschenkron (1952) and Solow (1956)] started to speak about the possibility of convergence between developed and developing countries. However, later in the 1980s and 1990s, the Western economists came to the general conclusion that this convergence is hardly possible at all.

Indeed, not so long ago many prominent economists still made such statements as:

> Empirical studies have shown consistent evidence of a cross-country income distribution displaying bimodality with a marked thinning in the middle. This result is interpreted as showing that poor countries are not catching up with the rich, but rather that there is evidence of club convergence, that is, polarization at the extremes of the income distribution (Cetorelli 2002: 30).

> Unfortunately (from the perspective of the world's poor countries), there is little empirical support for unconditional convergence. Most studies have uncovered little tendency for poor countries to catch up with rich ones (Abel and Bernanke 2005: 235).

> There is no evidence of convergence in the world income distribution over the postwar era… We therefore need to understand how the poor economies fell behind and what prevents them today from adopting and imitating the technologies and the organizations (and importing the capital) of richer nations (Acemoglu 2009: 17, 22).

And this was written at the time when the process of the Great Convergence was already well on its way. In fact, economists largely overlooked the Great Convergence exactly in that very period when it became irreversible. But the most surprising point is that even today, when the developing countries are the major contributors to global economic growth, the idea of the Great Convergence has not received appropriate recognition. It seems that here (as in many other cases) stereotypes prevailed over the scientific approach.

Our conclusion that it is possible to speak about the Great Convergence as a global process already since the 1980s and especially since the 1990s is significant not only because it is important to recognize this fact. The point is that, in our opinion, this process will largely determine the course of global economic and even political process in the forthcoming decades. Thus, the scientific theory of the Great Convergence becomes a tool of scientific forecasting.

The Issues Covered in the Present Monograph This book touches on many important scientific matters, because both the Great Divergence and the Great Convergence are very large-scale global processes. Of course, in this book we can only very briefly analyze many extremely important and relevant issues (such as the structural and demographic cycles, the Malthusian trap and opportunities to escape it, the variety of definitions of globalization and especially the collapse of the colonial system, the success and failures of the Green Revolution, and the peculiarities of the oil-exporting countries). But we have considered in substantial detail some other issues that appear of no less relevance for the subject of this book—such as the prerequisites for a breakthrough of the West in the Late Middle Ages (including a comparison of Europe and the East with respect to their innovative dynamics in different periods of their history), the description of the structure of the industrial revolution, the answer to the question why Britain became the birthplace of the industrial breakthrough (including the development and analysis of the characteristics of the British patent system), the influence of globalization on the deindustrialization of developed countries and the industrialization of the developing ones, the role of human capital dynamics, and so on. In addition, we believe it is essential to consider the origins of the Great Convergence, starting from the conception of the process, when even the possibility itself of convergence seemed very unlikely. Thus, we have also attached two special appendices dealing with a more detailed analysis of some of those issues.

The book's structure generally follows its title. Recall that we considered two major processes that are phases of a single superprocess, as well as an associated range of scientific issues. However, the Great Divergence has been studied by now much better than the Great Convergence; on the other hand, the notion of "the Great Divergence" has been already more or less recognized by the academic community,

whereas we introduce the notion of "the Great Convergence" for the first time right in this book. This necessitates some amendments to the structure of our book. Indeed, the idea of the Great Divergence in general has been recognized for quite some time, and even in its present form, it was presented about 20 years ago. In fact, virtually no one would dispute the fact that a sharp gap emerged between Europe and Asia by the end of the nineteenth century. Of course, there are some debates about rather important points, but still they occur within a generally recognized framework: when did the European lead start? From the mid-nineteenth century? From the beginning of the nineteenth century? Or earlier? In the eighteenth century? In the seventeenth century? Or even earlier? In the fifteenth century? In the fourteenth century? What were the reasons for it? When did the Great Divergence become irreversible? What causes determined the point that Britain became the birthplace of modern industry? How high was the level of development of the Asian societies in the early nineteenth century? And so on. All these and other issues are quite thoroughly discussed in Chap. 2 of this book. But we think that one chapter is sufficient enough to give a systematic description of the Great Divergence, as well as our interpretation of its phases, causes and driving forces. However, we discuss some points additionally in the appendices.

The situation is different with respect to the idea of the Great Convergence (let alone that this very term is only now being introduced). As has already been mentioned, even now most economists are not ready—despite evidence to the contrary—to recognize the reality or importance of this process (including the belief that the empirical evidence does not support its reality in a convincing manner). In this connection, we needed two chapters to prove the point.[5]

In Chap. 3 we analyze to what extent the process of the Great Convergence has advanced by now; in Chap. 4 we describe the causes and development of the process of the Great Convergence and provide our explanation of various factors of the Great Convergence. Finally, in Chap. 5 we offer forecasts of the geopolitical and geo-economic development of the world in the forthcoming decades on the basis of the proposed theory

Thus, the book consists of five chapters (including the first introductory one), that are complemented with two appendices.

As has been mentioned above, in Chap. 2 (*The Great Divergence and the Rise of the West*) we first of all give a sketch of the whole process of the Great Divergence and its transformation into the Great Convergence. This is followed by a detailed analysis of those factors that allowed the West to overtake the East in the Modern Period, as well as those factors that put in motion the process of the Great Divergence. This necessitates the consideration of certain aspects of the development of the East and the West from the mid-fifteenth century (and even earlier in some respects) till the late twentieth century.

Among the most important provisions that we develop in this chapter is the idea that, starting with the early second millennium BC, one can distinguish the potential

[5] In addition, we start discussing some processes that finally transformed the Great Divergence into the Great Convergence already in Chap. 2.

that later enabled Europe to overtake the East. However, for a long time Europe lagged far behind the East, and it managed to develop its potential advantages only in the Early Modern Period. We analyze in detail the reasons that enabled Europe to achieve this. Another important idea in this chapter is that we believe it is much more reasonable to consider the Industrial Revolution as a rather long-term process that started in the late fifteenth century and continued till the mid-nineteenth century. This process went through several phases, and, in our understanding, the period between the last third of the eighteenth and the first third of the nineteenth century (this period is traditionally denoted as the period of the "Industrial Revolution") was only the final phase of the Industrial Revolution, at which an irreversible transition to machine technology and at the same time to a new kind of energy occurred. But it was the most prominent and visible phase of the industrial revolution.

We do not consider the European nineteenth-century breakthrough as a really unexpected development, we rather view it as a fairly long process that continued from the fifteenth to the nineteenth century, during which in some respects (e.g. military-technical and scientific) Europe was already ahead of the advanced countries of Asia, whereas in others (such as the level of craftsmanship) it still lagged behind. But in general, we denote this period as "*catching up divergence*". All of the above said has allowed us to express our own opinion on the reasons for the Britain leadership in that period. Although Britain was clearly the leader at that point, but in that period we also observe a number of important processes that can be identified as pan-European (including the development of military technology, trade, science, pan-European commercial and industrial crises of the second half of the eighteenth century, and the beginning of the demographic transition). From this perspective, we clearly trace in the Industrial Revolution the result of the collective achievements of different European societies though that was a sort of relay-race of achievements (see also Appendix A).

Chapter 3 (*Great Convergence and the Rise of the Rest*). In the 1980s, 1990s, and even 2000s, many economists failed to detect behind the formal indicators the profound changes in the Third World that prepared for fundamental changes and the onset of the Great Convergence. In the meantime, as one can see from the figures in this chapter, the symptoms of the movement from the trend of the Great Divergence toward the Great Convergence already became apparent in the 1960s and 1970s. In Chap. 4 we demonstrate how much the process of the Great Convergence has advanced by now.[6]

[6]With its development the Great Convergence (like other similar comparable global processes) becomes a more and more complex process. In fact, at present we can talk not about a single group of developing countries (the Third World), but rather about a number of groups that differ in terms of levels and potentials of their development. Accordingly, within these groups, development proceeds rather unevenly. In the third chapter we offer a comparative analysis across Asian, African, Latin American, and Western welfare states, focused on a systematic comparison between the First, Second, Third, and Fourth (the "Bottom Billion") World. It shows that the widely used division of the world into the developed and developing countries becomes more and more obsolete every year. However, for a better understanding of how the processes of convergence and new divergence (among the middle income economies and low income countries) unfold, it is necessary

Chapter 4 (*The Great Convergence and Globalization: How Former Colonies Became the World Economic Locomotives*). Quite paradoxically, retrospectively one can trace the beginning of the process of the Great Convergence already in the nineteenth century when the European and Western domination seemed to have become overwhelming. The main reason of such a change was the necessity to support the Western industrial output and export of goods. However, as it was said above, this change caused a demand for the increase of the export of capital and technologies to the non-European countries. As a result, these encouraged both the growth of national movements for political and economic independence and the rise of a stratum of entrepreneurs with new business ethics. In the late nineteenth and early twentieth centuries, the increasing export of British and European capital also marked the start of the formation of the contemporary World System. The chapter traces the development of a number of colonial and dependent countries, the impacts of the two world wars on this process, as well as the collapse of the colonial system. We describe in detail the various factors that contributed to the process of convergence. We also offer a detailed analysis of the development of views on this convergence and explain why Western economists actually overlooked it.

Chapter 5 (*Afterword*: *The Great Convergence and Possible Increase in Global Instability, or the World without an Absolute Leader*). We want the final chapter of the present monograph not just to summarize our research; we would also like to offer forecasts of the geopolitical and geo-economic development of the world in the forthcoming decades on the basis of the proposed theory (which, incidentally, accounts for the concluding chapter's title). One of the important lessons that we have learnt is that, on the one hand, in the foreseeable future, we will observe the processes of economic and socio-cultural convergence between developing and developed countries, and, consequently, the reduction of poverty and illiteracy in many developing countries. However, on the other hand, this process will not go smoothly and without any setbacks; what is more, it will require a deep reconfiguration of the World System. This may mean a possible increase in instability and intensity of crises in the world in the forthcoming decades. Instability will be expressed globally due to increased confrontation and the search for a new balance of power and new alliances; but it will also be manifested at regional and national levels, due to the fact that the increased level of technology, culture and expectations may enter into conflict with the existing shortcomings of social and state systems, inequality and injustice. Of course, there are a number of other factors that can increase instability—like the upsetting of ethnic balance in the USA and European countries or the growth of national consciousness and anti-globalization feelings in those world regions that have been only weakly touched by the globalization processes by now. The problem of instability in the foreseeable future is closely linked

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to clarify the structure of the modern convergence, to elucidate the peculiarities of the world's countries distribution according to their GDP, per capita incomes and other important parameters. To a large extent this task is performed by a *Statistical addendum* ("On the Structure of the Present-Day Convergence") to Chap. 3. In the fifth chapter we also discuss the processes of divergence between the non-Western countries.

with the need to search for the principles of the new world order, as the change in the balance of economic forces in connection with the Great Convergence and increasing globalization will inevitably pose such a problem. However, it is important to note that future instability and clash of forces in the global field is likely to become noticeably dissimilar to the original confrontation between the First and Third World, between the former imperial centers and their former colonies. Neither will it be the clash of civilizations in Huntington's sense (although the ethnic and civilizational component will always be present in global tensions). It is the tension between the old and new players on the "global chessboard", which in the end (we hope) will not be a field of perpetual confrontation of geopolitical players, but, a field for the maintenance of a new field and somewhat more equitable world order. One of the novel ideas developed in the concluding chapter of this book is that the passing of the USA's hegemony will not lead to the emergence of a new global hegemon. We believe that in a direct connection with the development of globalization processes the hegemony cyclic pattern is likely to come to its end, which will lead to a World System reconfiguration and the emergence of its new structure that will allow the World System to continue its further development without a hegemon. We also suggest that the world middle class (that is growing primarily due to the Great Convergence) may create new possibilities for the political globalization and a fairer world order.

The Great Divergence and the Great Convergence are further scrutinized in the appendices.

Appendix A (*Technological Innovation Activities in Britain and Other Western Countries (1400–1900)*: *A Quantitative Analysis*) is devoted to the study of the dynamics of technical inventions in Europe from the fifteenth to the nineteenth centuries. Our quantitative analysis suggests that it is much more productive to regard the Industrial Revolution as a pan-European (or Western European) phenomenon, whereas the industrial breakthrough of the second half of the eighteenth century was just its final, although extremely important part. In fact, we had to develop this perspective, since this aspect of research has been scarcely studied. Our analysis of the technical innovation dynamics shows that:

- firstly, the British lead began to show up only in the second half of the seventeenth century; before that time Britain had clearly lagged behind Italy and Germany. Thus, during the two initial centuries of the Industrial Revolution Britain absorbed the achievements of European societies, and only then did it succeed to start its own innovative climb;
- secondly, though we observe the British evident leadership in the technological innovation from the second half of the seventeenth century to the first half of the nineteenth century, for a greater part of that period, the overall innovation activity of "the rest of the West" was higher than that of Britain. The primacy of Britain in the field of technological invention was absolute only during a relatively short period in the second half of the eighteenth century and the early nineteenth century—i.e., the period of the final phase of the Industrial Revolution;
- thirdly, by the first half of the nineteenth century the British endogenous technological growth rate virtually stagnated against the background of a very fast

increase of those rates in France, Germany and the USA, as a result of which those countries caught up with Britain in a rather significant way. Incidentally, it is just the ability of the other European countries to quickly adopt the achievements of the Industrial Revolution in England that confirms the idea that the Industrial Revolution was a European process (whereas Asian countries were able to undertake their modernization much later and mostly with great difficulties);

- fourthly, in the second half of the nineteenth century Britain finally lost its technological lead, as in the late nineteenth century the number of major inventions made in the USA, Germany, and France exceeded the number of British inventions.

Appendix B (*A Mathematical Model of Great Divergence and Great Convergence: Demography, Literacy, and the Spirit of Capitalism*) consists of three sections. In its first section ("Reconsidering Weber") we study the main assumptions behind the proposed model. One can hardly speak about any single reason which appeared to be the determinant of the change of the vector of development from the Great Divergence to Great Convergence. If the task was to define the most important reason (or rather a set of reasons) then, in our opinion, it would consist of the fact that the process of the growing connectedness of different countries aimed at supporting further innovative development sooner or later would demand equalization (at least to a certain level) of the developmental levels of different regions of the world. One can call this a "law of communicative vessels" in the global economy (this idea is developed in much detail in Chap. 4). Up to a certain moment this law did not work to its full extent as there were some social and cultural, and technological and political impediments required for its implementation. The first section of Appendix B demonstrates that the most important among these was the low level of human capital development (and especially with regard to modern formal education) in the World System periphery which did not allow any really effective diffusion of capital and technologies from the World System core. It is demonstrated with formal cross-national tests that during the period of the Great Divergence these were the countries with higher levels of literacy that tended to join the club of developed countries, as literate workers, soldiers, inventors and so on turned out to be more effective than illiterate ones not only due to their ability to read instructions, manuals, and textbooks, but also because of the developed skills of abstract thinking. By the way, this could explain to a considerable extent the differences between the economic performance of the Protestants and the Catholics in the late nineteenth–early twentieth centuries in Europe recognized by Weber. One of Weber's research goals was to show that religion can have independent influence on economic processes. The results of our study support this point. Indeed, the spiritual leaders of Protestantism persuaded their followers to read the Bible not to support the economic growth but for religious reasons, which were formulated as a result of ideological processes that were rather independent of economic life. We do not question that specific features of Protestant ethics could have facilitated economic development. However, we believe that we found another (and probably more powerful) channel of Protestantism's influence on the economic growth of the Western countries.

The second section ("A Mathematical Model of Great Divergence and Great Convergence") is devoted to the presentation of the model itself. As we said above it is very important to comprehend the Great Divergence and the Great Convergence as a single process. However, this idea demands examination in different dimensions. In this section we propose a simple mathematical model that is capable of describing mathematically both the process of the Great Divergence and the one of the Great Convergence. In this two-component model, the world is divided into the core and the periphery. For each of the two macro-zones the dynamics of three subsystems are modeled: (1) population; (2) the technological-economic sub-system; (3) the education-cultural (human capital) subsystem. With regard to initial conditions, the level of the development of sub-system 3 for the core is set to be significantly higher than the one in the periphery. According to the model, the value of this variable positively affects economic growth while it affects negatively population growth (reflecting the negative impact of the female education on fertility). On the one hand, the model describes the technological transfer from the core to the periphery (the catch-up term)—according to the model, the higher is the level of human capital in the periphery, the easier that the technological transfer takes place; on the other hand, the larger that the gap is between the core and the periphery, the higher the value of the catch-up term is; hence, the catch-up force is a very low at the initial phase with the very low level of human capital in the periphery. It becomes highest at the advanced phase when a wide gap between the core and the periphery is combined with a rather high level development of human capital in the periphery; and it decreases again at the final phase with the decrease of the gap between the developed and developing countries. Note also that within the model population growth is assumed to be affected positively by economic growth, but economic growth (both in the model and the real life) also promotes the development of education that finally leads to the decline of population growth rates. Within the model, in the first phase the core's GDP grows much faster than in the periphery because of the high level of human capital in the core (which stimulates the economic growth there) and the low level of human capital in the periphery (which inhibits both endogenous economic growth and the diffusion of high technologies from the core). Within the model this generates the Great Divergence. Note that at this phase within the model the population in the core grows faster than in the periphery, because the high economic growth rates outweigh there the influence of education that is not high enough in the core to inhibit sufficiently the population growth rates. In the second phase, the economic growth rates in the periphery increase mainly due to the development of the human capital there, as this promotes both endogenous economic growth and the transfer of advanced technologies from the core. However, at this phase the level of education in the periphery is not sufficiently high enough to decisively inhibit population growth and to raise economic growth rates to the core countries' levels; hence, in this phase economic growth in the periphery leads to a very substantial population growth, but as regards the GDP per capita, the gap between the core and the periphery continues to increase. Finally, in the third phase, human capital in the periphery develops to such an extent that it allows the peripheral states simultaneously to achieve both substantially higher endogenous economic

growth rates, and very high levels of technological transfers (reflected in the high value of the catch-up term), and a significant slowdown of population growth rates. As a result, in the third phase the GDP per capita growth rates of the periphery start to exceed substantially the ones of the core, and, as a result, the explicit Great Convergence begins within the model (note that the model also describes the fourth phase when the convergence rate slows down due to the reduction of the gap between the developing and developed countries, which leads to the decrease of the value of the catch-up term).

The dynamics generated by the model demonstrate a rather good fit with historical data, which supports the idea that the Great Divergence and the Great Convergence can be treated as a single process. The model also allows us to develop a forecast that suggests that the Great Convergence process will continue in the forthcoming decades, though its rate will experience a definite slowdown. Note also that the model suggests that we should expect a rather high correlation between the gap in GDP per capita between the First and Third World, on the one hand, and the growth rates of world population, on the other.

The empirical test that we have performed in the third section of the appendix ("Phases of Global Demographic Transition Correlate with Phases of the Great Divergence and Great Convergence") has rather unequivocally supported this hypothesis confirming the idea that the Great Divergence and Great Convergence constitute two phases of a single Global Modernization process being tightly intertwined with the other dimensions of Global Modernization. In fact, the correlation has turned out even stronger than we expected. We can hardly say that the dynamics of the Great Divergence and Great Convergence are determined entirely by the dynamics of the global demographic transition. The onset of the modernization process, including the reorganization of politics, economy, and social life, occurred due to many factors. However, we are quite ready to claim that, once begun, the impact of modernization on incomes was strongly dependent on the timing of the phases of the demographic transition in different regions. The dynamics of global population growth and the Great Divergence and Great Convergence therefore may be considered to be so closely coupled as to be two sides of the same coin. Note also that our empirical analysis has confirmed the accuracy of interaction between the phases of the global demographic transition, the Great Divergence, and the Great Convergence generated by the mathematical model presented in this Appendix.

Chapter 2
Great Divergence and the Rise of the West

In this chapter we will analyze those factors that allowed the West to overtake the East in the Modern Period, as well as those factors that put in motion the Great Divergence process. This necessitates the consideration of certain aspects of the development of the East and the West since the mid-fifteenth century (and even earlier in some respects) till the late twentieth century.

A General Analysis of the Development of Asia and Europe

As is widely accepted at present, by the early second millennium CE Europe lagged far behind the main eastern countries in terms of development of the productive forces, statehood, urbanization, consumer culture, scientific achievements and other relevant parameters (e.g., Crone 1989; Abu-Lughod 1991; Pomeranz 2000; Maddison 2001, 2010; Christian 2004; Goldstone 2009a; Lucas 2005; Saliba 2007; Reinert 2007; Vries 2013), whereas, according to some estimates, the per capita GDP in the advanced economies of the East was at least twice as high as in Western Europe (e.g., Мельянцев 1996: 74). According to some other estimates, even in the eleventh century, Western Europe did not reach the level of production of the first century CE Roman Empire (e.g., Cameron 1989; Maddison 2001, 2010). The items that prevailed within the export of European countries to the East were fur, silver, and timber (Abu-Lughod 1991: 47; Postan 1987). Eastern Europe, in addition to valuable furs, also exported honey and wax, as well as skins, and considerable numbers of slaves (Gieysztor 1987; Postan 1987; Ali 1999), whereas the Eastern exports to Europe consisted mostly of finished industrial (handicraft) products and luxury goods (Abu-Lughod 1991: 47; Postan 1987; Ali 1999). In short, in the early second millennium CE Europe looked like a backward periphery of the Asian and North African core.

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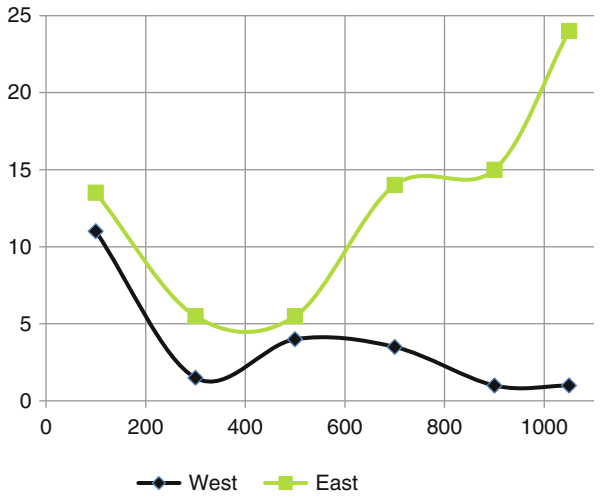


Fig. 2.1 Inventions and discoveries in the West and the East per century, *1–1100 CE* (The Divergence of the first millennium CE). *Note*: For the period between 1 and 1000 CE the diagram indicates the average number of inventions and discoveries made per century within the respective pair of centuries. For example, the number "11" corresponding to the European datapoint for year 100 indicates that the average number of inventions and discoveries made in the first and second centuries CE was 11. Two last datapoints (at 1050 CE) correspond to the number of inventions and discoveries made in Europe and the East in the eleventh century

Consider specially, how Europe, that is Western Europe or the "West", lagged behind "the East" as regards such an extremely important indicator as the intensity of innovation in science and technology. In order to insure the compatibility of the analysis results we will use here and elsewhere[1] the database on scientific discoveries and technological inventions created by Hellemans and Bunch (1988). To start with, consider the levels of innovation activity in the East and the West during the first eleven centuries CE (Fig. 2.1):

As we see, in the early first millennium CE the levels of innovative activities in the East and the West were rather comparable. Both in the East and in the West the World System crisis that started in the second half of the second century CE with the "Antonin Plague" pandemic (see, e.g., Korotayev 2006) led to a very significant decrease of the rate of innovation within science and technology. However, in the second half of the first millennium in the East (but not in the West) one could observe a rather significant increase in the number of serious inventions and discoveries; as a result, the East managed to recover its scientific-technological activity to the pre-crisis level—and to exceed it substantially by the eleventh century. As regards this indicator, in the first eleven centuries CE one can observe a rather clear divergence between Europe, on the one hand, and Asia and North Africa, on the other (and not in favor of Europe), which, no doubt, contributed rather strongly

[1] With some exceptions that will be mentioned specially below.

to the retardation of the West (in comparison with the East) that became so salient by the eleventh century CE.

However, while Europe lagged far behind Asia, by the eleventh century it had some potential advantages—first of all, it had more stimuli to invest in labor-saving technologies, and it was better provided with sources of energy (e.g., Chaunu 1979; Wigelsworth 2006). Of course, those potential benefits could be realized only under certain conditions. Such conditions began to take shape in Europe in the centuries that followed; an important role was played by the readiness of some Western European societies to borrow technologies from the East and to improve them. At the same time in the East in the Early Modern Period, even long-known methods of mechanization could not be applied widely, and their application even sometimes declined (see, for example, Ванина 1991: 96–98 with respect to India; Landes 2006 about China, and Allen 2011 as regards Japan).

Technical and Scientific Upswing of the Late Medieval Period in Europe and the Question of the "Early Industrial Revolution" In the period between 1100 and 1400, but especially in the fifteenth and sixteenth centuries, the European labor-saving tendencies became implemented to a sufficiently large degree (see, about the sixteenth and the next centuries, e.g., Huang 2002), which resulted in a fairly rapid development of technologies and a number of key inventions (more about them see below and also in Fig. 2.2) and the development of the process of division of labor. This technological upswing that took place in Europe between 1100 and 1600 was noticed long ago—back in the 1930s—starting with the work of Lewis Mumford (1934), Bloch (1935), Carus-Wilson (1941) and was actively studied by economic historians in around 1950–1980 (Lilley 1976; Forbes 1956; Armytage 1961; Gille 1969; White 1978; Gimpel 1992; see also Hill 1955; Johnson 1955; Bernal 1965; Braudel 1973; see Lucas 2005 for more details). This period also quite rightly considered as the time of scientific breakthrough, or rather a number of revolutionary breakthroughs in such areas as mathematics, astronomy, geography, cartography, etc. (see, e.g., Singer 1941).

The analysis of the Hellemans—Bunch database may suggest that with respect to scientific-technological growth rates the West caught up with the East as early as in the twelfth century, whereas in the second half of the thirteenth century the West might have already somehow outrun the East (see Fig. 2.2).

However, one should take at this point into account the following consideration. The point is that, starting from the twelfth century, Hellemans and Bunch appear to have become obsessed with the registration of the explosively growing stream of the European inventions, and that is why they start to pay much less attention to the registration of the Eastern scientific-technological innovations. That is why there is good cause to suppose that the decline of the scientific-technological activity rates suggested by Fig. 2.2 may actually be an artefact of such an underregistration. In this respect, it has turned out to be necessary to use a data survey on the dynamics of the number of innovations in science and technology in China in the period between the tenth and nineteenth centuries (Goldstone 2009a: 122).[2] Its application

[2] Note that in his turn Goldstone based himself on the survey produced by Li and Soylu (2004).

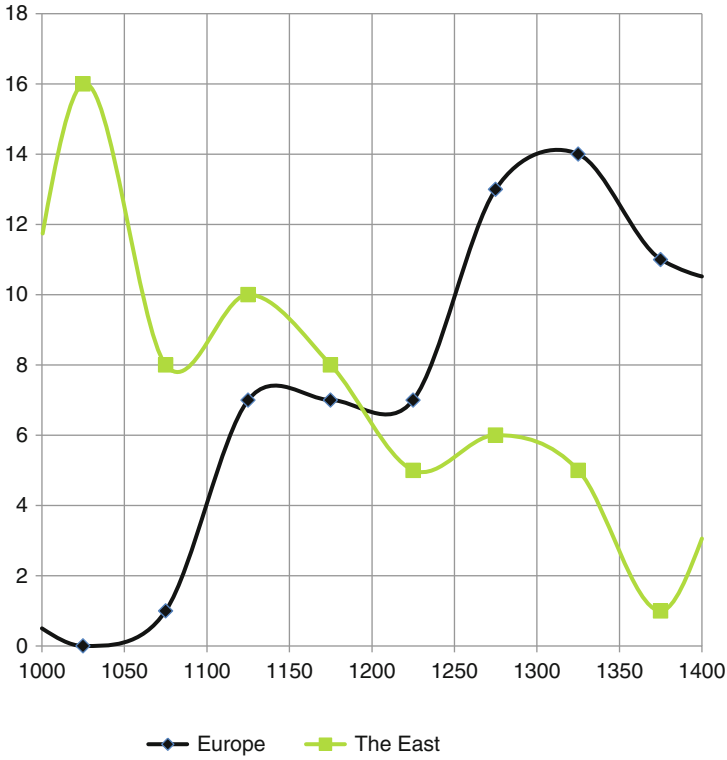


Fig. 2.2 Inventions and discoveries in Europe and the East per half a century, *1000–1400 CE. Note*: each datapoint indicates the number of inventions and discoveries made in a respective half of a century. For example, the number "14" corresponding to the European datapoint for the year 1325 indicates that the number of inventions and discoveries made between 1300 and 1350 in Europe was 14. *Data source*: Hellemans and Bunch (1988)

produces the following result (see Fig. 2.3) that appears more reliable than the one presented above in Fig. 2.2.

According to these data, Europe failed to outrun China (as regards scientific-technological growth rates) not only in the twelfth or thirteenth, but even in fourteenth century. On the other hand, the figures above suggest a rather vigorous acceleration of those rates in Europe in the twelfth century with one more such acceleration in the thirteenth century (when Medieval Europe produced its first paradigm changing inventions—initially, the invention of the spectacles and the mechanical clock).

Thus, it is clear that the theory of early industrial revolutions that preceded the Industrial Revolution of the eighteenth century has rather solid foundations (Lilley 1976; Forbes 1956; Armytage 1961; Gille 1969; White 1978; Gimpel 1992; Lucas 2005; see also Hill 1955; Johnson 1955; Bernal 1965; Braudel 1973]). However, later this theory was (without any reasonable grounds) relegated to the periphery of

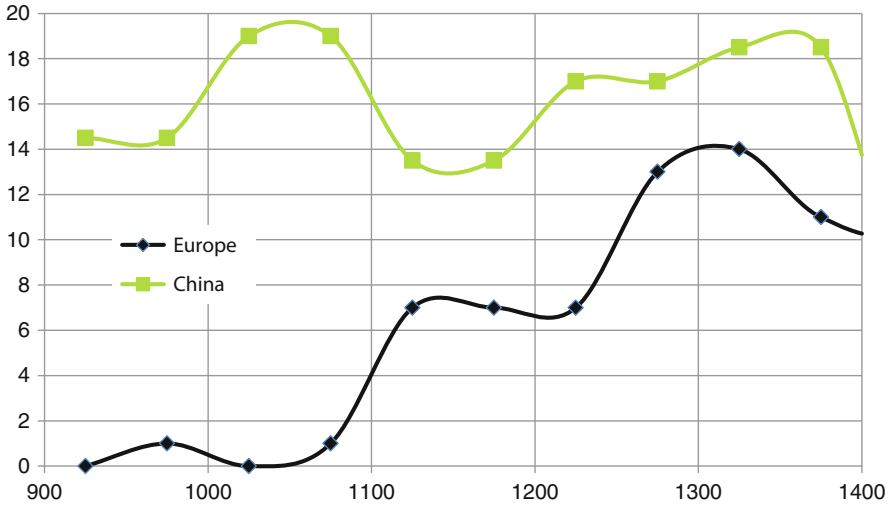


Fig. 2.3 Number of innovations in science and technology in Europe and China per half a century, 900–1400 CE. *Data sources*: Hellemans and Bunch (1988) and Goldstone (2009a: 122)

the historical mainstream (for example, researchers belonging to the California School hardly mention the early European industrial revolution). However, ignoring the early European industrial revolution, we believe, appears to be counterproductive in solving many important problems, including the search for reasons why the Industrial Revolution occurred in Britain (see below for more details). In addition, this question is somewhat artificially separated from the more general question about the causes of the technological breakthrough in the West in the Early Modern Period. Our view is that the idea of the early industrial revolution in explanatory terms is very useful, but it requires its own conceptual development from a perspective that allows treating this early revolution not so much as a separate isolated phenomenon, but as the initial phase of the Industrial Revolution. Then in fact the industrial breakthrough of the eighteenth century must be regarded as the final phase of the Industrial Revolution. We would say that the Industrial Revolution continued for at least three centuries; and against the background of many millennia that preceded those three centuries—this was a rather short, quite revolutionary period.

Very schematically, this approach may be outlined as follows. The period between 1100 and 1450 may be regarded as a preparatory period of the Industrial Revolution with quite a vivid manifestation of early capitalist relations and forms of production in some regions of Europe (Northern Italy, Southern Germany, the Netherlands, Southern France (see, e.g., Pirenne 1920–1932; Wallerstein 1974; Postan 1987; Мильская and Рутенбург 1991; Lucas 2005).

The period from the late fifteenth century till the early seventeenth century (often denoted as “the long sixteenth century”) is the initial phase of the Industrial Revolution, associated with the development of navigation, engineering and the

mechanization on the watermill basis, the diffusion and the improvement of different machines, and the development of division of labor. At this time, in different parts of Europe, there were significant breakthroughs in a variety of directions, which by the end of the period are synthesized into the general Western European system (Johnson 1955; Braudel 1973; Wallerstein 1974; Барг 1993; Ястребицкая 1993б; Davis 1996). Changes in one country tended to produce substantial impact on the economy and the lives in other countries—through the spread of innovations, through the publication of special technical books, through the movement of technical experts to different countries, through the introduction of various advances and innovations by kings and emperors to their realms, etc. Thus, we find impressive achievements in the field of mechanization in mining operations in Southern Germany and Bohemia; major contributions to the development of navigation, geographical discoveries and world trade accomplished by the Spanish and Portuguese, but also by the British; significant developments of technologies of manufacturing in Italian and Flemish cities; significant shifts in agriculture in Northern France and the Netherlands; important scientific and mathematical discoveries made by scientists in Italy, France, Poland, England; and finally, new financial technologies developed in Italy (Hale 1993; Davis 1996, 2001; Collins and Taylor 2006; Goldstone 2009a, 2012b; Ferguson 2011; Porter 2012). But all of this, anyway, quickly became the common heritage of Europe.

The period from the early seventeenth century to the second third of the eighteenth century is the middle phase, when one could observe the formation of a complex industrial sector and the capitalist economy with increased mechanization and the deepening division of labor. This is the age of trade leadership by the Dutch, the successor to the hegemony of Spain and Portugal. The Netherlands created an unprecedented industry of shipbuilding, mechanized port facilities and fishing (Boxer 1965; Jones 1996; de Vries and van der Woude 1997; Rietbergen 2002; Israel 1995; Allen 2009). But the seventeenth century was a century of very large changes in military technology, science, and engineering; whereas as a result of wars and other processes the Netherlands lost its leadership, which was gradually moving to Britain (Rayner 1964; Boxer 1965; Snooks 1997; Jones 1996; de Vries and van der Woude 1997; Rietbergen 2002).

Finally, the period between 1760 and 1830 may be identified as the final phase of the Industrial Revolution, which was also accompanied by the creation of the sectors of the machine cycle of production and the use of steam power. Although Britain was here clearly the leader, we also observe in this period a number of important processes that can be identified as pan-European (including the development of military technology, trade, science, pan-European commercial and industrial crisis of the second half of the eighteenth century, the beginning of the demographic transition—see below). In this concept, we clearly see in the Industrial Revolution the result of the collective achievements of different societies of Europe, a sort of relay-race of achievements (see also Appendix A).

Three Peaks of the Filling of the Ecological Niche: 1300–1880 The recent research (whether it belongs to the California School, or not) justly pays much

attention to the standards of living in different periods and in different countries (Allen 2009, 2011; Clark 2007; Pomeranz 2000; Huang 2002; Goldstone 2009a; Vries 2013). However, in our view, it is not completely correct to reduce all the measurement of pre-industrial history to the assessment of quality of living [as is done, for example, by Clark (2007)], presenting this assessment in the form of a Sisyphean labor of technological progress in the fight against the Malthusian Trap, when all the societies' efforts were in vain, as the growth of the population "ate" the growth of production. Clark (2007) has repeatedly pointed out that in 1500–1800 the standard of living (or rather the workers' wages) fluctuated below the fifteenth century level that emerged after the fourteenth century Black Death. He uses this to support an idea that there was no real economic growth until the early nineteenth century, as any economic growth that is not resulted in the growth of the standards of living cannot be regarded as real. He does not seem to see the connection between population growth and qualitative development including the growth of sociocultural complexity. We believe that *in terms of macroevolutionary approach what was more important for the industrial breakthrough of the ongoing Industrial Revolution was not the rise of the standards of living, but rather simply population growth that also stimulated the development of institutions and the statehood, systems of knowledge, social culture, and methods of preventing mass disasters (such as counter-epidemic measures, public grain stocks, etc.). On the other hand, the development of institutions and the sufficient complexity of social systems are essential for any significant sustained population growth.*

The Neolithic (agricultural) revolution allowed human populations to move very significantly over the naturally determined carrying capacity limit, to widen their ecological niches through various technological innovations, which (in combination with the development of complex sociopolitical structures) already present in the pre-Industrial era resulted in the formation of societies with populations in the millions, dozens of millions, and even hundreds of millions. Yes, in the pre-Industrial epoch there was no continuous sustained growth as regards per capita calorie consumption or the diet quality of the majority of population, but there was very considerable growth as regards the global population and global GDP (e.g., Maddison 2001, 2010; Korotayev et al. 2006a; Livi-Bacci 2012). According to various estimates, the world population increased from 225–300 million in the first century AD to almost a billion people by 1800 (Durand 1960; McEvedy and Jones 1978; North 1993; Kremer 1993; Maddison 2001, 2010; Korotayev et al. 2006a; Livi-Bacci 2012; Grinin et al. 2013). In our opinion, from general evolutionary perspective, the Industrial Revolution, in principle, could not begin until the world population had reached a high enough level. Indeed, when there were significant reserves of the territory in which the surplus population could move, there was no need for radical change in the type of production that existed. This type of production could not change radically until the world population (together with production and trade) had reached a certain critical level. Clark (2007: 318) wonders why the Industrial Revolution could not happen in ancient Babylonia around 1800 BCE or in ancient Greece around 500 BCE. In fact, it could not happen there, because a critical mass of population and technologies that was necessary for the Industrial

Revolution had not accumulated to any sufficient extent either by 1800 BCE, or by 500 BCE.

Only the filling of the global ecological niche and the simultaneous filling of the global political niche (that is the coexistence of a large number of highly complex polities having sufficiently close contacts with each other) led to a sufficient intensification of production, and consequently a sufficient need in innovations (Grinin 2008a, 2011a, 2012a; Grinin and Korotayev 2006; Korotayev and Grinin 2006, 2012a).

However, after the filling of a given niche, the transition to a new higher attractor does not happen automatically. In some cases (that are much more frequent) the filling of an ecological niche resulted in socio-demographic collapses (see, e.g., Turchin 2003, 2005; Turchin and Korotayev 2006; Turchin and Nefedov 2009; Korotayev and Komarova 2004; Korotayev et al. 2006b; Korotayev and Khaltourina 2006; Korotayev et al. 2011a, b; Grinin 2012b), and only in very rare cases did the transition to a new higher attractor take place (Korotayev et al. 2006b; Grinin 2012a, b). In this regard, if we look at the dynamics of the population in Europe, then we can talk about three peaks, and three evolutionary attempts to escape from the Malthusian trap and to move to a new type of economy.

According to some estimates, by 1300 the population of Western Europe had reached the level of 55–60 million, in 1500 (after the catastrophic depopulation produced by the Black Death and subsequent recovery) it turned out to be basically the same—*c*. 55–60 million, but by 1600 it increased to 70–75 million. In Europe (as well as in most other parts of the world) the population growth rates declined very substantially (sometimes even to negative values) in the seventeenth century (see, e.g., Parker 2013), however, they accelerated rather significantly in the eighteenth century, and by 1800 the population of Western Europe reached the level of 115–120 million (Clark 1968: 64; Russell 1972; Cipolla 1972: 36, 1981: 4; Maddison 1991: 226–227, 2001, 2010; McEvedy and Jones 1978: 49, 51, 107) (see Fig. 2.4).

Thus, after 1300 one could observe the first attempt to surpass the carrying capacity ceiling that resulted in socio-demographic collapse in connection with the Black Death epidemic, crop failures, socio-political destabilization, and also the change of climate that became colder and moister (Flohn and Fantechi 1984: 37, 39; McNeill 1998; Клименко 2009; Livi-Bacci 2012); the decline of population in England, France, Germany, Spain and Italy between 1347 and the first half of the fifteenth century is estimated at 30–40 % (Livi-Bacci 2012: 44).[3]

However, this socio-demographic collapse was not a complete return to the old, but an important transition that strengthened labor-saving processes, started the process of technological innovation, and paved the way for the start of the industrial revolution (Herlihy 1997). The beginning of the next evolutionary attempt can be dated to the end of the fifteenth century, when we find in Europe approximately the same population as two centuries before. As a result, one can speak about the start

[3] "There are no precise data on the scale of the decline between the period before 1348 and the population nadir reached during the first half of the fifteenth century, but a loss of 30–40 % is corroborated by local studies in Piedmont and Tuscany, and in France, Spain, England, and Germany" (Livi-Bacci 2012: 44).

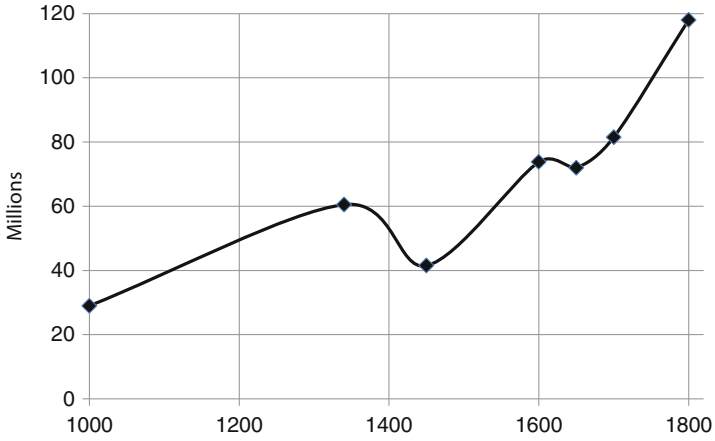


Fig. 2.4 Population dynamics of Western Europe, millions, 1000–1800

of the Industrial Revolution since the late fifteenth century. This attempt to get out of the Malthusian trap was more (but not yet fully) successful than the previous one, thanks to innovations in agriculture, protoglobalization, and the rapid growth of international trade (Гринин et al. 2009; Гринин and Коротаев 2012). A time around 1750 can be considered as the beginning of the third evolutionary attempt, which ended with the industrial breakthrough and—finally—secured the escape from the Malthusian trap (for more details on those three attempts see Мельянцев 1996: 99).[4]

The Period Between 1400 and 1800: Divergence or Convergence Between Europe and Asia? In the nineteenth century the Industrial Revolution put into motion the process of the Great Divergence, which lasted for more than a century. The Great Divergence led to the predominance of the West as regards almost all the standard indicators (except population)—thus it is possible to speak of a comprehensive divergence. However, the process of divergence began several centuries before this, when the West was in some ways ahead of Asia, in some other ways the West was standing with Asia at approximately the same level, and as regards a number of important parameters, the West still lagged behind the East. Therefore, the process of divergence at this time did not cover all dimensions, but only some of them (such as, say, military and technological development, science, methods and the scope of dissemination of information, etc.). In the Early Modern Period, some technological points in which the West was ahead of the East, were not too significant for the economy as a whole (such as larger scale of application of "inorganic" energy), but later their importance increased.

[4] It should be also noted (though it goes beyond the scope of our research) that all three picks of the filling of the ecological niche, as well as their regression, were connected with the climate change (e.g., Flohn and Fantechi 1984; Мельянцев 1996: 85–88; Клименко 2009; Parker 2013).

Jack Goldstone suggests an interesting idea implying that it makes sense to "decompose the notion of the 'Great Divergence' into a number of distinct smaller 'divergences' that arose in different times and places, and which eventually led to the critical advances in science, technology, and productivity that powered nineteenth century European dominance" (Goldstone 2013: 59). Additional research is needed to identify such "smaller divergences". Goldstone suggests his own version of such an identification in a number of his publications (2008b, 2009a, 2013), whereas below we will outline a version of ours.

However, it appears essential to emphasize that this period was at the same time a period of convergence (catch-up), as in this period the West was rather actively catching up with the most advanced societies of the East as regards a number of very important dimensions (such as the level of the development of statehood, urbanization, literacy, some sciences, ship tonnage, quality of manufactured goods, and so on).

Note that Europe caught up with the advanced societies of the East at different points of time with respect to different indicators. Note also that in some narrow technical aspects (such as the technology of printed calico fabrics) the West could simply borrow technology or expertise, but in many other respects the process of catching up by the West was carried out in entirely different ways in comparison with what was previously observed in the East, so the reduction of the gap (that is convergence/catch-up) was achieved through the development of a different trajectory (i.e., through divergence).[5]

Therefore—in view of the fact that at the same time we could observe processes of both divergence and convergence—we would suggest to denote the period between 1450 and 1750 as a period of **catching up divergence**. Further we will return to the additional explanation of this concept. Here we will comment on only one of its aspects. The discovery of the New World significantly changed the situation not only for Europe but also for Asia and Africa. The most important consequences for Europe were the influx of precious metals, the use of the New World colonies for the production of industrial crops, as well as strong growth in trade on this basis. However, for Asia the main consequence was not the growth of trade with Europeans (which did not have a large share in the total trade of the Asians) and even not the influence of the influx of the New World silver. For Asia the most important consequence was the borrowing of a number of very important American crops (the latter proved to be also immensely important for a number of societies in Sub-Saharan Africa). Note that they diffused throughout Asia even faster than throughout Europe. It is difficult to overestimate the importance of corn, potato, sweet potato, cassava, peanuts, etc. for population growth in Asia (and Africa). Thus, for Europe the discovery of America meant the growth of wealth, for Asia it meant the possibility of the continuation of the previous course to ensure the conditions for the maximum growth of the population. In this regard, the old divergence increased.

[5] Generally, by the end of the Middle Ages the West was superior to the East only in certain military, navigation and a few other technologies (e.g., Parker 1997), whereas in most respects the East was more developed than the West.

Divergence as a Synthesis of Various Revolutions Both the catching up (incomplete), and the full (Great) divergence can be understood more profoundly, if we consider them as a result of several interrelated revolutions that produced a truly synergistic effect. *Within this set of revolutions, each revolution made a significant contribution to the process of divergence*. First of all, this is the Industrial Revolution in its initial, middle and final phases. Each phase marked a change of technology and the development of powerful means of production, of change in an energy base, communications, etc. Note also that in the second half of the eighteenth century we already observe the beginning of the demographic revolution (the demographic transition) (see, e.g., Armengaud 1976; Minghinton 1976: 85–89; Cipolla 1976: 15; Вишневский 1976, 2005). However, even earlier, in fact, since the fifteenth century, we observe in Europe cultural and information revolutions, which manifested themselves in the spread of printing, the achievements of the Renaissance, the Reformation, and the Great Geographical Discoveries. It is difficult to overestimate the importance of the proliferation of practical knowledge and literacy. It is also necessary to mention the first scientific revolution in the seventeenth and eighteenth centuries, the harbingers of which were already visible in the sixteenth century. Without science, the Industrial Revolution would not have had a lasting basis (see Goldstone 2009a; Allen 2009; Рейснер 1986, on the scientific revolution). Finally, all this was accompanied by a military revolution [or more precisely, military revolutions (Duffy 1980; Downing 1992; McNeill 1963; Parker 1996)] whose importance tends to be underestimated by the California School. Meanwhile, the processes that in the European countries resulted in the formation of regular armies, continuously improving artillery and other weapons, and fortification and supply systems can hardly be overestimated in terms not only of technology (and science), but also in terms of the development of European statehood (Гринин 2010; Grinin 2012a); note also that the "colonies", to which Pomeranz (2000) pays so much attention, did not appear from nowhere). After all, the regular army can neither be created nor supported without a developed state apparatus, the development of literacy, enhancements of the taxation system, the financial system, the development of communications, social reforms, etc. Constant war, with all its negative aspects, demanded reforms, it demanded to learn from the achievements of rivals, which was a powerful source of development. Some aspects of some particular revolutions will be discussed below, but, of course, each of them requires a special study in terms of their impact on the Divergence.

History of Foreign Trade and the Great Divergence Nowadays, the foreign trade structure can tell us a lot about how developed the economies of the respective trade partners are. It is also important to understand which partner needs trade relationships more. The same can be said about the economies of the past. It appears necessary to immediately note that till the last third of the nineteenth century Europe needed the trade with the East (especially with the Far East) more than vice versa; though those countries that had close contacts with Europe (such as Turkey or Egypt) felt this need much earlier.

On the other hand, in less complex societies, e.g., in Sub-Saharan Africa (not to mention stateless Amerindian societies) the need for European goods was originally much more. The history of foreign trade in Europe and Asia is rather telling in terms of our theme. In the eleventh, twelfth, and thirteenth centuries, in connection with the Crusades, Europeans were actively drawn into the trade with the East. In this and the subsequent period up to the Great Geographical Discoveries, the main European imports from the East included—in addition to manufactured products—spices; but Europe itself had almost nothing to offer in return. At the same time, the process of import substitution began in Europe, as Europeans learned how to make paper, silk, etc. (see, e.g., Burns 1996). During the period of the Great Geographical Discoveries the scale of trade between the West and the East enormously increased; trading routes changed; and—what appears to be especially important—the European trade got tightly connected with the naval advantage of Europeans (although it was not enough yet to change the balance of power dramatically). However, the imbalance in trade with the East was huge, and to cover a huge trade deficit the Europeans had to increase their silver productions several times—as the silver was the main thing the Europeans could offer in order to be able to buy desired Eastern goods. The first serious increase in silver production was achieved in Central Europe (in particular in Bohemia and Saxony) in the 1460–1530 period (Nef 1987: 735), which was a response to the "Silver Famines" of the 1320s to the 1460s (Spufford 1987), then great quantities of silver started to be produced in the Spanish colonies; a substantial role in covering the trade deficit between the West and East was played by gold obtained by the Europeans in West Africa. However, the fact that the West was a worldwide leader in the production of silver was, in reality, one of the main sources of its power.

At the same time, with the emergence of East India Companies, imports of manufactured goods from the East further increased—especially fabrics from India, which were famous for their quality for centuries. Thus, still Asia surpassed Europe in terms of volume, value, quality of manufactured products, and—in some respects—in terms of technology (see, e.g., Ванина 1991). The fact that the most developed countries of the East (China, Japan, and others) did not need European goods was confirmed by their seclusion policy, which since the seventeenth century was pursued by the East Asian countries—China, Japan, Korea, and Vietnam. Import substitution in Europe was a process that started in the late Middle Ages. With the emergence of American colonies, it acquired new dimensions, as this allowed an opportunity to grow important technical crops that previously had to be imported (sugar cane, coffee, cotton, tea). In the seventeenth century Britain (and a little earlier France) began to independently produce cotton fabrics.[6]

[6] However, in the late seventeenth in France, under the pressure of manufacturers and sellers of silk and woolen cloth, Colbert imposed a total ban on production of cotton cloth as it rivaled strongly the former; in England (for the same reason) it was prohibited partially (Mantoux 1929; Чичеров 1965; Allen 2009; Аллен 2014). It is important, that in Europe the textile industry needed raw materials, while for silk and porcelain production there was a complete circle (from raw stuff to finish goods). Cotton seems to be the only popular article supplied by Asia in that time.

Thus, in the trade between Europe and Asia, there was an important change, which was the forerunner of the Great Divergence. Asia became a supplier of raw materials in bulk; these exports started growing rapidly since the late 1730s (which coincided with the weakening of bans on the production of cotton fabrics in Britain and with the invention of Kaye's loom). But even after 40 years from the beginning of the industrial revolution, in spite of the tremendous progress in reducing the cost of production, as late as in 1802, exports of yarn and fabrics to India from Britain in this period was not reasonable yet, because the cost of a pound of the British fortieth number yarn was 60 pence, almost one and a half times higher than in India (Allen 2009). On the other hand, imports of cotton were growing.[7]

Finally, the powerful extension of the English textile exports to India started; this marked the final victory of Europe over Asian manual manufacturing and the transition of the Divergence to an open and vigorous form of separation. Yet even in the mid-nineteenth century, for establishing large-scale trade with the Far East countries, Britain, France, and the United States still had to use military means (including threats of war or even explicit warfare). European goods flooded Asia, and Asian agriculture started to readjust more and more to fit the European demand; the share of industrial crops in Asia grew rather substantially.

The Great Convergence process also got under way, but almost immediately the process of opening and expanding markets (that was an integral part of this process) started to require export of capital in general and massive investments in infrastructure in particular, as well as in the expansion of production of raw materials in the countries of the World System Periphery. Large-scale construction of communications in some colonies, including telegraph and postal service, was rather impressive. The development of communications, infrastructure, and education also opened an opportunity for the export of industrial capital. Western technology began to penetrate the East. This was the beginning of the turning point—with the looming perspective of Convergence (for more details on this process see Chap. 4 of this monograph; in this paragraph we discuss it very briefly).[8]

Great Divergence in the Apogee The Great Divergence is also an important part of the process of globalization, which was largely influenced by European powers, and European coercion, but eventually induced the Eastern countries to start the process of modernization to catch up with the West, a successful model of which—Japan—became an indicator suggesting that the ways of the East and the West are not fatally different. *The period before the First World War can be seen as the*

[7] From 1750 to 1850, Britain raised its consumption of raw cotton from one thousand to 267 thousand metric tons (Mitchell 1978: 253). But by 1850 the rest of Europe also imported about 130 thousand metric tons more (Mitchell 1978: 253).

[8] In this respect, the period from 1870 to 1990 seems to be to a certain extent a reflection of the sixteenth and eighteenth centuries. In the sixteenth-eighteenth centuries, one could observe a powerful hidden divergence between the West and the East which showed up after the 1800s. The period between 1870 and 1990 can be characterized as a period of hidden convergence which in the form of vector of the converging per capita GDP production started to show up only after the late 1980s.

apogee of the divergence, whereas afterwards one could observe more active processes that were preparing for the Great Convergence. Moreover, a sort of synergetic process started: the more active colonies began to demand independence, the more that the center tried to do for them. The process of development of the colonial and semi-colonial periphery accelerated as a result of two world wars. We can say that in general, they contributed significantly to the development of local industry and economy, and the growth of national consciousness.

The Great Divergence is not just a process of growing differences in the levels of development of the West and the Rest, but also the process of the emergence of a new type of global economic system in which economies of various countries were incorporated into a single world economic system (but with very different roles). This aspect of the process of the Great Divergence has been widely studied by the world-system analysts (Wallerstein 1974, 1980, 1988; Frank 1979; So 1984; Arrighi 1994; Chase-Dunn 1998; Chase-Dunn et al. 2000; Amin 2010; Chase-Dunn and Lerro 2013, see also Grinin and Korotayev 2012a, 2013a, b); however, some of them have failed to notice the transition from the Great Divergence to the Great Convergence that happened in recent decades.

The Last Stage of Divergence and Globalization Finally, the post-war period can be regarded as a new stage of relations between the East and the West. Several revolutions converged here that in a few decades turned the trend of Divergence toward Convergence, that in the last decades was largely connected with the upswing of globalization:

1. the liberation of developing countries from colonial and semi-colonial dependence, which contributed to the emergence of different models of development, to the formation of modern extracting and manufacturing industries in many of these countries, as well as to the development of national intelligentsia;
2. the 1950s and the 1960s are traditionally considered as a period of new technological revolution (scientific-technical, and information revolution (Grinin 2012a; Grinin 2013), see also Bernal 1965; Benson and Lloyd 1983). On the one hand, this acceleration even intensified the process of divergence. But, on the other hand, the results of this revolution were actively applied in developing countries;
3. in the 1960s a new wave of fertility decline began in the First World (the so-called "second demographic transition" (Lesthaeghe and van de Kaa 1986; van de Kaa 1987, 1994; Lesthaeghe 1995), whereas in the developing world, in the 1950s and 1960s one could observe an even more rapid decline in mortality against the background of still rather high fertility levels. By the end of the 1980s this led to a reduction in the working age population in the World System center against the background of its rapid growth in the World System Periphery, creating a particularly strong incentives to transfer labor-intensive industries from developed to developing countries;
4. one may also mention the so-called Green Revolution in a number of countries, which helped to provide their populations with the necessary minimum of food on a rather secure basis—this increased substantially food security in those countries creating a good basis for the start of a successful catching up;

5. an important role in the development of a number of countries was played by the oil crisis of the 1970s that resulted in huge financial resources being invested in the development of oil-producing countries and their neighbors;
6. one may speak about the transition to a new ("post-industrial") type of economy in Western countries, where the services sector started playing a dominant role. Accordingly, this paved the way for the transfer of industries to developing countries;
7. many countries adopted the idea of catch-up modernization, which contributed to the development of their industry, education, etc.;
8. globalization, which increased the "transparency" of economic borders significantly by the early 1990s, thus raising the intensity of the flow of capitals and technologies from the Center to the Periphery of the World System to critical values;
9. to a high degree, this was supported by the development of new information technologies.
10. finally, also largely due to globalization, the majority of developing countries in the early 1990s managed to reduce the gap with developed countries in terms of the development of human capital to a critically low level, which provided a real possibility to transfer a very large number of industries from the Center to the Periphery of the World System, providing a dramatic increase in the flow of technologies and capitals from the First World to the Third World, and triggering the onset of the Great Convergence. In this regard, we can say that the Great Convergence was launched by a new wave of globalization that began in the late 1980s and the early 1990s.

The courses and processes that prepared the transition from the Great Divergence to the Great Convergence will be discussed in more detail below in Chap. 4.

Some Preconditions of the Great Divergence in the Early Modern Period

As has already been mentioned, the Early Modern Period is the period of catching up divergence when the foundations of the Great Divergence were laid. But before considering these processes, it is necessary to look at those factors that contributed to the breakthrough of the West. We agree with Goldstone (2013: 59) that it is necessary "to abandon… the notion of Europe as having an inherent, durable advantage or superiority in some respect that goes back thousands of years". However, it would not be reasonable either to deny that certain prerequisites for a breakthrough in Europe already existed in the Early Modern Period (and even prior to it).[9]

[9] In fact, the abovementioned statement of Goldstone in its full form looks as follows: "the only way forward is to abandon *both* the notion of Europe as having an inherent, durable advantage or superiority in some respect that goes back thousands of years, *and* the notion that there was no essential difference between Europe and other major civilizations until relatively late, around 1800" (Goldstone 2013: 59).

Consider some of the features that helped Europe outstrip Asia (of course, first and foremost in terms of production and economic performance). First, we will list them, then take a closer look:

1. Technological features
   1a. A higher level of labor-saving and mechanization;
   1b. The propensity to borrow and to develop borrowed technologies;
2. Structural features of the economy
   2a. The relatively high proportion of a non-agricultural population in some countries of Western Europe in the Early Modern Period;
   2b. The greater role of trade and the financial sector in the economy;
3. Socio-economic features
   3a. Lower levels of government intervention and larger levels of private initiative;
   3b. Greater autonomy of European cities and the higher prestige of trade and financial nobility;
4. Evolutionary features
   4a. The East outgrew suitable demographic proportions for a revolutionary breakthrough.

Some Comparisons Between the West and the East: Technological Peculiarities

Higher Levels of Labor-Saving and Mechanization For a long time there was no clear advantage of the West in this respect, that is why, before the thirteenth century it appears more correct to speak rather of the inclination to labor-saving (in connection with a sparse population, on average less fertile soils and generally with a smaller deficit of cultivable land than in the East). But we must remember that for a long time, it was a sort of latent advantage that in many respects looked rather as a defect.

In this capacity, labour-saving and mechanization became noticeable only in the sixteenth to seventeenth centuries and later. Significant elements of the growth in labor productivity due to the appearance of new mechanisms could be found in the Middle Ages in the eastern countries too (see, for example, Боголюбов 1988: 19). This was particularly important in relation to irrigation (and in this respect for a very long time the West clearly lagged far behind the East).

Some Features of Agriculture in the West and East What were the factors that contributed to the development of the situation when the process of labor-saving through mechanization in Europe became considerably stronger than that in the

East?[10] Population and its density in Europe were much smaller than in the densely-populated countries in Asia (see more about this below).[11] As a result, Europe for a long time (up to about the eleventh and twelfth centuries CE) had a considerable reserve of unused land, but also in later periods many European countries often dealt with a direct shortage of workers. The growth of labor-saving was supported not only by a sparse population, but also by relatively poor soils [Meliantsev (Мельянцев 1996: 77)] believes that the overall productivity of the land in Europe in the Middle Ages was five times lower than in the countries of the East, cf. Huang 2002). In other words, even when the shortage of land in Europe increased and farmers started to apply more effort in order to increase the productivity of land (using multiple tillage, crop rotation, etc.), the price of labor as a factor of production was still higher (due to demographic and other reasons) than in the East, especially in China. Therefore, Europe paid more attention to labor-saving. It is important to also take into account a higher share of wage labor in agriculture in North-Western Europe as compared to China (e.g., Goldstone 2007: 213), which increased the demand for labor-saving—it does not make much sense to save the labor of family members who are not paid specifically, but it makes sense to hire fewer workers.[12]

Some researchers do not quite distinguish between the productivity of labor and productivity of land. As is noted by Huang with respect to one of the founding fathers of the California School, "what Pomeranz has done, here and elsewhere in his book, is to fail to grasp the crucial distinction between land productivity and labor productivity and between labor intensification per unit of land and capitalization per unit of labor" (Huang 2002: 507). However, this is critically important when we consider the difference between these two regions. Thus, for the eighteenth century, according to Huang's (2002: 509) calculations,[13] the cultivation of one acre of rice in the Yangzi needed 2.4 times more labor hours than the cultivation of an acre of wheat in England. "In terms of pound weight, the Yangzi delta yield was roughly 3,432 pounds per acre, while the English was roughly 1,290 pounds. That is a differential in grain output between the Yangzi Delta and England of about 2.7 to 1 per unit of land" (Huang 2002: 511). This difference accounts for the difference in population densities up to a considerable degree. Note also that the abovementioned difference was observed in the eighteenth century, after the Agrarian Revolution in England that brought about a very significant growth of both the productivity of land and the productivity of labor.

[10] One of such reasons was a prohibition of slavery in Western Europe while there were comparable many slaves in eastern countries especially in the Near and Middle East.

[11] A larger population density in Asia as compared to Europe was promoted by the fact that in Europe the share of arable lands was relatively larger, namely, 45 % of total territory compared to 23 % in Asia (Галич 1986: 188; Рябчиков 1976: 124, 342).

[12] For example, "in England *c.* 1750, more than half the population engaged in wage labor either full-time or part time; farmers and freeholders in agriculture were only about a quarter of households. In Japan and China… a much smaller proportion of the population were laborers" (Goldstone 2007: 213).

[13] In their turn, Huang's calculations are based on Buck's (1937: 314) data.

As regards China, Huang (2002: 513) calls this "involuted economy": "that same involuted economy, however, for reasons to be made clear below, meant counter-incentives against modern labor-saving capitalization of agriculture, and the consequent persistence of low agricultural labor productivity, and therefore also of low rural incomes". That was the heart of his idea of growth without development. We are not ready at all to identify the pre-Modern Chinese development pattern as a true "involution", "growth without development". However, we would agree that this pattern in the Early Modern Period did not lead to new evolutionary levels because sooner or later it led a society to the Malthusian trap, though every time this process widened its ecological niche.

Labor-Saving Through the Introduction of Energy Technologies So, although the mechanization of work developed both in the East and in the West, ultimately, due to the above mentioned reasons, in the West labor-saving technologies developed more actively. Therefore, in the Medieval West one could observe a rather active diffusion of both old labor-saving inventions and new technologies, including those borrowed from the East. Thus, the water mill was invented a 100 years before our era, but within the Roman Empire slave labor prevented its spread, although the vertical wheeled water mill was used as a preferred technology for some industrial applications (Wikander 2000).

But already in the Early Middle Ages, watermills quickly and widely spread in the West. For example, in England in the eleventh century, according to the census of William the Conqueror ("Domesday Book"), there were 5,600 watermills in 3,000 villages (Hodgen 1939; Cameron 1989). According to other reports, in France at that time, there were about 20 thousand watermills (Debeir et al. 1991: 75). Taking into account the difference in population in both countries, there was one mill per every 250 people (Мельянцев 1996: 81). In the eleventh century the total per capita energy potential of mills in Europe (at least in England and France) was higher than, for example, in the Near East (from where the mill came to Europe) 1.5–3 times (Мельянцев 1996; Léon 1977; Issawi 1991).

In Europe, mechanization was also expressed in a more complete use of animal power. Thus, according to Persson, in England in the eleventh century about 70 % of the consumed energy was produced by domestic animals (Persson 1988: 28; see also Cipolla 1978: 53). The use of improved harnessed for horses, horseshoes, and other improvements allowed making the overland freight in Europe sufficiently profitable to do business at a relatively long distance. According to some estimates (see, e.g., Lilley 1966), the cost of land transport in comparison with the period of the Roman Empire fell three times. According to some researchers, horse efficiency increased greatly with only the use of the clamp increased very much (4–5 times), this in general contributed to the progress in a number of areas of the economy (e.g., Мельянцев 1996; Cipolla 1981; North and Thomas 1973; Scott 1989; White 1962; Bolich 2005; Chamberlain 2006; Wigelsworth 2006). As a result, the level of energy consumption per labor input in Europe was growing, and by the mid-twelfth century, it caught up with the countries of the Muslim world and China (Мельянцев 1996: 82; Pacey 1990: 44), and in the thirteenth century, according to Chaunu, it exceeded the corresponding indicator by 2.5 times, and then the gap could only

increase, reaching a 4–5 time difference in the sixteenth century (Chaunu 1979: 288). True, we should also take into account the colder climate of Europe, which requires heating (on the use of wood and coal in Britain see Allen 2009, on general state of the transport see Postan 1987).

Labor-Saving in Craft Technologies: The Role of Epidemics Finally, the crises of the fourteenth and fifteenth centuries (especially the Black Death) strengthened labor shortages to a critical degree; on the other hand in a few parts of Western Europe (including England this was accompanied by the actual emancipation of the serfs, which greatly transformed the feudal structure (North 1996). Labor became not only scarcer, but also freer, which created especially strong stimuli for the development and introduction of labor-saving technologies. No wonder that since the fourteenth century the process of dissemination and improvement of various mechanisms (presses, wheels, mills etc.) accelerated (e.g., Lucas 2005).

But, of course, such epidemics themselves could often also lead to economic degradation (see, e.g., Borsch 2004, 2005 with respect to Egypt). And only the special circumstances (in which some countries of Western Europe found themselves during the epidemic) transformed the terrible disaster into a factor of the subsequent breakthrough. At the same time, in countries where consumption was relatively low and the labor was relatively cheap, the motivation for labor-saving was weaker (see, e.g., Huang 2002; Allen 2011).

Inclination to Borrow Technologies and to Develop Them It is very well-known that in the Middle Ages the West borrowed numerous technologies from the Middle East, North Africa, China, India and the other Asian societies (Al-Hasan and Hill 1991: 278–280; Ashtor 1978: 295; Raychaudhuri and Habib 1982: 47–52, 285; Elvin 1973: 85, 113–130, 167; Lal 1988: 48; Mokyr 1990a: 23–24; Needham 1981: 13–14; Watson 1981: 29–30; Pacey 1990; Hall 1980; Goldstone 2009a). As Epstein notes, "Medieval Europeans may have been the first of the great free riders benefiting from borrowing the best practices of others" (Epstein 2009: 192).

However, an important feature of Europe was not only the ability to borrow innovations (and not only in the technical field) but also their creative development. Somehow it turned out that these innovations in the developing Europe began to play a more important role than in their homelands (this applies to such borrowings as mills, watches, mechanical printing, gunpowder and firearms, the compass and others; even the wheelbarrow was made more effective by Europeans with the front wheel, and not under the platform, as in China). For example, in the thirteenth century, Leonardo Fibonacci introduced the use of Arabic numerals that found their main application in trading accounts. Already in only a few decades each merchant's apprentice had to know the four rules of arithmetic, which had previously been known only to a handful of scientists.

The reasons why many innovations acquired a greater importance in Europe than in their homelands are varied, and in addition to the above mentioned need in labor-saving and relatively high military, political and economic competition, there was a whole system of interrelated and mutually re-enforcing factors, providing a higher degree of adaptation and diffusion of innovations. Some factors will be discussed below.

Some Comparisons Between Europe and the East: Structural Features of Economic Systems

A Relatively High Proportion of the Non-agricultural Population In Early Modern North-West Europe one could find a rather high proportion of the population living in rural areas, but engaged in non-agricultural activities (see, e.g., Allen 2009; Carus-Wilson 1987; Postan 1987). One of the reasons was the geographical position that allowed active use of fishing and sailing (Gieysztor 1987; Postan 1987); lower agricultural productivity (so that the intensification of work in it did not bring much, thus stimulating non-agricultural activities) and a higher level of the development of animal husbandry, providing industrial raw materials and fertilizers. And with the growth of urbanization, in some Western European countries the total share of all the non-farming populations grew and eventually overtook the level of the advanced Eastern countries. The non-farming population provided a large labor pool for the emerging hand and then machine industry.

The more Important Role of Trade and the Financial Sector in the Economy The fast growing role of trade (and, especially, foreign trade) in the economy of a number of European countries appears to be of extreme importance starting from the eleventh century—even in comparison with the situation in the Arab world.[14]

Trade in Europe grew continuously in volume and geographical expansion from the tenth century to the first decades of the fourteenth century (Postan 1987: 208), and then, after a period of epidemics and wars, again began its growth in the late fifteenth century (Van der Wee 1990, 1994; Monro 1994; Snooks 1996, 1997). Note also the higher the role of maritime transport. And as we will show below, the trade often led any industrial enterprise. According to some of Chaunu's estimates, in the sixteenth century the amount of land transport in North-Western Europe doubled, and the sea transportation increased 5–10 times (Chaunu 1979; Léon 1977). In the period between 1500 and 1700, the foreign trade in the Western European states increased 3–5 times, whereas the trade with the countries of the East and the South grew more than 15 times (Bairoch 1985: 174; Gould 1972: 221; Mann 1986: 472; O'Rourke et al. 2010; Parry 1980).

In Europe, as perhaps nowhere else in the world, there were many trade-oriented polities, as well as their unions of those polities, which has been noted by many researchers (see, for example, Dobb 1963b; Snooks 1996; Mielants 2007). These potential advantages became especially visible due to changes arising as a result of the Great Geographic Discoveries. It should also be noted that nowhere else in the world was the fishing and hunting of large aquatic mammals carried out at such large distances from the coast, and similarly as industrial processes, as in Europe in the late Middle Ages and the Early Modern Period (see Braudel 1973; Чистозвонов 1978: 147; Зингер 1981: 42–43; see also Kehoe 1992: 243; Keller 2010).

[14] On the large role of trade in the Arab world see, for example, Abu-Lughod (1991), Goldstone (2009a).

Trade, which played an increasingly important role in the Western world, could not develop without the development of the financial sector. And in this area, Europe was ahead of Asia already in the thirteenth to fourteenth centuries. Of course, financial credit systems were quite well developed in the East, and paper money first appeared in China, but nowhere were credit systems were developed so firmly and permanently as in Europe. Fernand Braudel devoted a special place to this process, believing that capitalism began to develop in the field of finance and credit (Braudel 1973). Note, that in all cultures this process was hindered by religious or ideological dogma. But in the world of Islam and Confucianism these values were stronger than in the Christian world, especially after the spread of Protestantism (Kuran 2011; Goldstone 2012a).

No wonder, that financial crises caused by disorder of credit or defaults began to shake Europe since the sixteenth century. We can assume that the divergence between Europe and Asia began in the financial sphere earlier than in other areas, which can be compared with the fact that the recent wave of globalization also began primarily in the financial sector.

Some Comparisons Between the West and the East: Socioeconomic Peculiarities

The Lower Level of Government Intervention and Stronger Private Initiative The factor of high private initiative (which existed before the twelfth to thirteenth centuries when free lands were available) had important significance. It was also especially important that for a very long period it coexisted with little state intervention—at first just because of the weakness of the European states and the particular influence of the Catholic Church, which contested political supremacy. Plow farming in Western Europe was less productive than in the East, but nevertheless, unlike a number of eastern states, European states did not take part in raising the productivity of land. It was a private matter. However, this combination of private initiative and less state regulation really emerged much later, probably already in the Early Modern Period (though state regulation by this period had increased, it never was so strong in Western Europe in many respects as in China and some other Asian countries). As a result, in the late Middle Ages and the Early Modern Period, the share of savings, which came in the form of private investment in land in Europe began to grow (Trevelyan 1978; Wilson in 1980; more on that below).[15]

[15] In the East, especially in China, Mesopotamia, or Egypt sometimes the state could invest large amounts of money in the land amelioration, but since the state itself developed in a cyclic manner, the process of such improvements was not sustained and sometimes the irrigation amelioration declined completely. In the West, starting from the Modern Age, the investments in land or agricultural technology generally increased.

One could observe a gradual development of specific and favorable balance in some western countries: the state protected property owners and did not allow over oppression of them, of the owners, including former feudal lords who had lost political rights, and who could not substitute for the state and destroy it (see, for example, Acemoglu and Robinson 2012). In some cases, the alliances of owners could effectively influence the behavior of the authorities, forcing them to pursue policies that supported trade (Greif 2006). The institution of private property was further improved. In conditions of a more stimulating legal environment and greater economic freedom, the economy begins to grow faster. We agree with those scholars who believe that without such a development of the institution of private property, industrialization could not have taken place. Therefore, it seems not quite right, that a number of economic historians, fascinated by comparing quantitative indicators such as the level of consumption, labor productivity, etc., began to attach less importance to the fact that the institution of private property in Europe was better developed than in the East (for example, Clark 2007; Allen 2009; Popov 2014). We do not agree with such a position. Without such institutions, above all the institutions of private property and intellectual property, the industrial revolution simply could not start (North 1981; North et al. 2009; Acemoglu and Robinson 2012; Greif 2006).

In contrast to what was often the case in the East (especially in China), where the state could sometimes develop production of their own, accumulating huge material and human resources, or by using direct commands, prohibitions, and orders, in Early Modern Europe and in the nineteenth century direction was gradually established: the state started paying more and more attention not to the direct impact on the economy, but rather the administration of it indirectly.[16]

European Cities as Centers of Self-development An often noted feature of European cities is their role as centers of industry and commerce that economically and sometimes politically dominated the surrounding countryside. But, of course, many cities in the East were primarily centers of crafts and trade (see, for example, Ванина 1991 on the Indian case; about the rise of some new towns as centers for cotton and silk processing and marketing in the Yangzi Delta of the eighteenth century see, e.g., Huang 2002: 519). Therefore, perhaps a more important role was played by the considerable independence of the inner life of the cities. Of course, in the beginning of the second millennium the degree of urbanization of Europe lagged behind that of the East, but the growth of cities there proceeded very actively. Already by 1500 in Europe, there were more than 150 cities with a population of ten thousand

[16] It is quite natural that there was an abundant evidence of the direct impact of the prohibitions that were spread in the seventeenth-century France during Colbert's times (see Rayner 1964: 42–44; Малов 1994: 142–150) as well as in other parts of Europe in general. We also do not consider here the epoch of catching modernization in Europe and Japan in the second half of the nineteenth century, when industrialization (including the construction of railways and telegraph) was to a large extent directed and financed by the state (see, e.g., Supple 1976: 329–330, 340–351).

and more (Blockmans 1989: 734). In some places, Europe reached an unprecedented level of urbanization.[17]

Besides, in general, Western European cities had much higher levels of self-government and urban freedoms in the law-making [with respect to property, economic circulation, forms of government, taxation, and regulation on its territory (e.g., Greif 2006)]. Note also that almost all the Western European cities were small. Thus, according to Issawi's estimates (Issawi 1980), large (with population of more than ten thousand) cities of such Middle Eastern countries as Turkey, Iran, Egypt concentrated 10–20 % of their population (see also Галич 1986; Мейер 1978).

In general, in the Middle Ages, most countries of Western Europe did not have practically any really large cities (see, for example, Chandler 1987). Correspondently, almost all city-dwellers lived there in small towns. On the one hand, they looked small, disorganized and unsanitary compared to their large eastern counterparts. On the other hand, smaller European towns were more flexible; they had a higher evolutionary potential. The presence of a large number of small towns increased evolutionary diversity and opportunities to develop specialization. In addition, one may notice similar features in some European trade communities and their alliances as trade-military expansion (Mielants 2007; see also Pearson 1997; Brady 1997).

Indeed, the military and commercial expansion was typical both for the period of the Great Geographical Discoveries, and for the later period, but one can still agree with Goldstone that the significance of this factor is often exaggerated (Goldstone 2009b). However, another point might be more important. In Europe one could find, as nowhere else, a very large number of societies (Italian merchant republics, the Netherlands, Hanseatic cities, some cantons of Switzerland, etc.), in which the financial and commercial bourgeoisie (merchants) had a very high social rank and prestige and nobility could consist of a range of aristocratic families deeply engaged in trade, where trade was the focus of public policy. All this created the conditions for the growing importance of the merchant class, which increased the efficiency of the merchants' corporate strategies (Greif 2006). Note that for a long time the development of industry could not go beyond the trade movement, so the development of industries was often concentrated in the hands of the same commercial-industrial nobility, since the capitals that were necessary for the development of industry were accumulated by trade activities.

[17] In the Southern Netherlands, half the population or even more lived in towns (Bruges, Ghent, and Antwerp), the share of the urban population was still larger in Northern Italy in the Po valley where Venice, Milan, and Genoa were situated (Blockmans 1989: 734). Such a high share of the urban population could be supported only by profitable trade. That is why its decline in the Italian Republics (as well as in the Southern Netherlands as a result of the destruction of Antwerp (the Spanish Fury) led to their transformation and stunted development.

Territorial and Demographic Proportions

The East Overgrew Suitable Proportions for a Breakthrough In addition to a number of conditions outlined above for the transition to new economic forms, a social system also needed some optimum proportions as regards its territory and population (Sanderson 1995, 1999; Allen 2009; Grinin 2012a). This required a large overall territory (which Europe had in the aggregate), but the population of individual societies should not have been very large.

It is obvious that the leading countries of the East with their huge (by European standards) populations did not fit in the right proportions for the evolutionary transition to the industrial society. The difference between the societies with their population in millions and the ones with their population in hundreds of millions is enormous. Like ancient slavery, the excessive population of the East also led the development of a deadlock, since it could only be reproduced under the control of very sturdy and developed states or other comparable rigid systems (such as the Indian caste communities) that did not provide conditions for breakthroughs to new levels of complexity, since the main task of such institutions was precisely to ensure stability in spite of all the changes.

In addition, the state that controls the lives of tens and hundreds of millions, on the one hand, tends to have more developed political and administrative forms, but on the other—it is much more difficult to change such a society than a society with population in millions. That is why, in the seventeenth century even in France, with its 20 million population, it was more difficult to achieve a radical restructuration than in England with its five million. The Netherlands only had a population of three million, but this country had a very high percentage of urban population. Back in the early sixteenth century, more than half of the Dutch population lived in cities (Hart 1989: 664), and in contrast to Flanders and Italy, this country was able to keep such a structure. Note that in the seventeenth century it had to cover by imports a quarter of its demand for bread (Cameron 1989; Якубский 1975; Сказкин 1968). It is clear that in the Early Modern Period such a large percentage of urban population was not possible with a huge Chinese population. Note also that the shift to more intensive agriculture in England associated with fencing led to the situation when in this not very large country (that in the fifteenth century was still in an acute need of working hands) an excess number of people suddenly appeared (part of them left the country, and the other part came under severe repression of the Tudors' Poor Laws). And where would tens of millions of "unnecessary" people in China or members of numerous artisan castes in India go? And did it make sense for large Asian states to contribute to such processes? In a sense, by the time when Europe groped a breakthrough of technological development, the Eastern systems had already lost this chance.

Catching Up Divergence of the Early Modern Period

Above, we have identified some significant differences between Europe and the East (but not all differences, for a full analysis would require a special study). Of course, both Western and Eastern societies constantly changed. However, the overall trend appeared as follows: the most developed European countries were constantly catching up with the most developed countries of the East, and in certain respects they even left them behind. And in those respects (which included science, military/navy technologies, and some fields of engineering) the gap between the West and the East was constantly increasing in the Early Modern Period. However, up to a point, this superiority had not yet materialized in the West's overwhelming dominance.

Thus, the Early Modern Period in relation to the theme of our study is characterized by a twofold process. On the one hand, we observe a process of convergence, but we also observe a partial advance of the West in comparison with the most developed Eastern countries in many ways. This duality (on the one hand, a higher level of overall development in the East, on the other—the growth of partial advantages of the West) has led to numerous disputes in which each party is in its own right. That is why we prefer to denote the Early Modern Period as the period of "catching up divergence". Indeed, during this period, on the one hand, Europe was still lagging behind the East, it was catching up with it in many respects. Thus, this was a convergence in a number of respects (such as literacy, urbanization, national culture, productivity, industrial production volumes), and a divergence with respect to some military-technical and scientific aspects, the dissemination of knowledge, and so on. It is very important to take into account the point that in the Early Modern Period the convergence could not be achieved by the West by rapid population growth (on the contrary, until the mid-nineteenth century, the gap in population between China and Western Europe only increased, see Fig. 2.5).

Also, we have seen that the difference in population (a relatively small population in European countries) was an important advantage. Convergence was mainly due to the development of technologies. An important role was played by the so-called military revolution, which, on the one hand, was a part of the development of new technologies, and, on the other hand, this revolution deeply restructured European states, making them bureaucratic, transforming them into a new type of state—developed and mature (see Grinin 2012a; Grinin and Korotayev 2006; Korotayev and Grinin 2006, 2012a, 2013).[18]

That is why we call this period of the Early Modern European history the period of **catching up divergence**, because Europe both caught up with the East in those

[18] With respect to the early (gunpowder) military revolution, one should note that the matter was rather ambiguous. The Ottoman Empire was among leaders in this sphere and produced a significant impact on its neighboring countries, both European and Eastern (Iran and India). But unlike Europe, the further development of military revolution failed there. Moreover, starting from the late eighteenth century first Turkey and later all other Oriental countries began to adopt the European achievements.

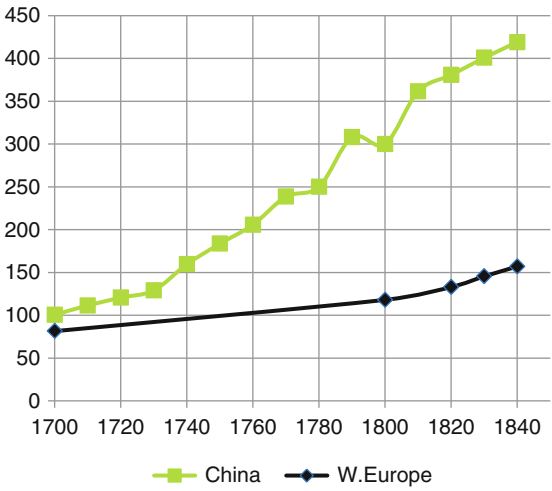


Fig. 2.5 Population dynamics in China and Western Europe, 1700–1840, millions. *Data sources*: Durand (1960), Zhao and Xie (1988), Korotayev et al. (2006b), Cipolla (1972: 36, 1981: 4), Clark (1968: 64), Maddison (1991: 226–227), McEvedy and Jones (1978: 49, 51, 107) and Maddison (2001, 2010)

respects in which Europe lagged behind it, and Europe simultaneously already started diverging from the East in many other respects until conditions had been created for the Great Divergence.[19]

Conditions, Driving Forces and Consequences We have seen that in the West there were quite serious prerequisites to overtake the East. But conditions could remain potencies for a long time, and would have a chance to be realized only in certain, quite unusual circumstances. The most important of these conditions are: (1) the thirst for wealth and the increasing concentration of effort to get hold of the wealth of the East. Note that the rich Eastern societies simply could not have such a stimulus; (2) the Age of Discovery, which became an unexpectedly successful result of the search for wealth; (3) changing ideas about the world and the rupture with the intellectual traditions of the past (Goldstone 2009a), which amplified the process of accumulation of knowledge that already clearly manifested itself in the fourteenth century and the first half of the fifteenth century, but which later was transformed into a systematically accelerating process of the production of scientific and technical knowledge.

It is important to understand that these conditions in an unprepared society could not become a source of major transformations that we see in Europe in the Modern Period. Processes of change in commerce, industry, agriculture, intellectual activity, in the accumulation of knowledge and science, in changing attitudes towards monetary wealth, in military organization and technology, shipping, and so on were already very evident in Europe even before the Great Geographical Discoveries. It is obvious that, although Europe generally lagged behind Asia, between 1000 and 1500 CE, the gap declined significantly, and, on the other hand, Europe in this

[19] Kuran (2011) denotes the period between the sixteenth and eighteenth centuries as "the Long Divergence". But in our opinion, this definition fails to reflect the actual significance of that period.

period produced a number of its own extremely important innovations (including in such fields as optics, chronometry, and artillery). But without these innovations, this economic and cultural progress could quickly exhaust its momentum, and with them it received a powerful reinforcement and expansion of the base.

Desire for Wealth, Its Diffusion in Society, and the Growth of Expansionism The relative poverty of European countries together with the abundance of the elite and primogeniture became the initial mover for the European attempts to conquer the world (clearly manifesting itself in the Crusades).

Geographical discoveries and colonial acquisitions, the growth of trade and industry, and the dissemination of knowledge about the successes—all these contributed to the expansion of this desire in Europe. And when this was accompanied by the "sanctification" of wealth by a new reformist religion, the desire for enrichment affected all sectors of respective societies.

And since the possibility of enriching was increasingly associated with the new lands and trade with them, *the course toward expansionism and globalization became an essential condition and the engine of the catching up divergence*.

Rich East Asia (which did not have any real need in the expansion of trade with the West) finally responded to western globalization in a somehow inadequate way. With increasing contacts with Europeans, who, together with the promotion of trade, tried to diffuse Western values (especially religious ones); all the major East Asian countries opted to pursue strict seclusion policies with respect to the Europeans (leaving only restricted, rigorously controlled channels for contacts with them).

On the Role of Sudden Wealth for European Development We find it appropriate at this point to discuss important consequence of the abovementioned changes, which is not so often debated, as it should be. One of the most important parameters, where Europe was much inferior to Asia, was the amount of resources that governments could concentrate for specific purposes. This difference stemmed from the enormous differences in population density, and the level of political centralization and economic-ecological potential. Europe was a relatively poor part of the world where it was rather difficult to concentrate massive resources. By contrast, the magnitude of the concentration of resources in China (when the government really wanted to) could be staggering. With proper organization of the state, the Chinese government could achieve impressive results. That is why the eastern monarchs did not have such an acute need to look for means to make the state richer, as it was rich enough already, the question was more in the proper organization of resource collection and utilization. Not surprisingly, the fleet of Zheng He and the size of his ships were so superior as compared with the fleet of Columbus (Goldstone 2009a). Note that in this case it was not a result of the technological backwardness of the European states. It is known that in the fifteenth century the Europeans could build very large ships of a thousand and even more ton displacement. The problem was rather the relative poverty of the Medieval European kingdoms. For the expedition of Columbus the Spanish government could only provide rather small ships simply because it could not find funds to support a larger-scale expedition supplied with

larger ships (which were generally quite available in Europe at that time). But the Great Armada that the Spanish state managed to dispatch 100 years later was already much closer in its size to the fleet of Zheng He. The point is that during that century the wealth of European monarchs (and especially the Spanish ones) grew in a very considerable way indeed.

Starting from the 1530s, the flood of precious metals, which flowed into Europe from the New World, dramatically changed this situation. Since the Spanish gold and silver anyway spread over the whole of Europe anyway [in particular, by 1600 no less than 40 % of state revenues in Spain was directed to service old debts (McNeill 1982)], a situation of a sudden enrichment of Europe emerged. But in contrast to this enrichment, which was realized in the additional production of food (which within the pre-Modern Malthusian systems tended to encourage the population growth), the wealth came in Europe in a rather concrete form of precious metals, as monetary wealth. To some extent, it was like a sudden enrichment of a conquering country, similar to what was, for example, in the empire of Tamerlane. However, this conqueror spent the captured wealth on such things as embellishment of Samarkand, whereas in North-West Europe it went into business and produced an immediate increase in the volume of investments in many sectors; this wealth was turned into a growing flow of goods from the rich East.

The growth flywheel was already running. According to McNeill, the rise in prices began to act as a social solvent, which facilitated the rise of the middle classes to the political heights in North-Western Europe (McNeill 1963). And it turned out to be impossible to stop this flywheel (in particular, it was fueled by the ever-increasing volume of colonial exploitation of the New World). The power of the growth flywheel was such that in the eighteenth century, many European countries (with a small population size by Asian standards) could support huge armies and keep them on a permanent basis, to build huge fleets, fortresses and the like, that is, they were already comparable with large Asian societies as regards their ability to concentrate resources. This could occur as a result of the overall growth of wealth, which the increasing part was expressed in due to the accumulation of money and could be monetized, but also due to the development of the giant credit business, in particular the institute of national debt and the development of the tax system (see, for example, Bogart et al. 2010). Thus, in many ways it was the rapid growth of wealth in the form of money in the sixteenth century that started the process of the catching up divergence at a much higher rate than before. We also note that Spain and Portugal (and other European countries—through various transactions with them) acquired a unique position in the world, as they became the owners of resources for the production of the world currency. This also allowed increasing the real wealth of European societies, due to the constant excess of imports over exports.

Desire for Import Substitution in the West As already stated, it was the West that needed goods of the East (and not vice versa)—the West had little to offer Asia (wool and glass products, iron tools, fur, and even African ivory—that is almost the whole list). Throughout the Early Modern Period exports from Asia to Europe

definitely prevailed over the exports from Europe to Asia (see, for example, Frank 1998; Held et al. 1999; Pomeranz 2000; Goldstone 2009a; So 2012).[20]

Imbalance in trade with the East intensified pursuit of import substitutions in Europe. This implied the search for possibilities to produce various valuable oriental goods: silks, porcelain, sugar, coffee, tea and so on. And what was the import substitution in the prevailing conditions of the Early Modern Period when respective technologies could not simply be bought? Within such a context import substitution implies a search for innovation. So it is not surprising that import substitution in respect to cotton fabrics was one of the incentives for the industrial revolution.

Between 1614 and 1725 the volume of import of cotton textiles in England had increased by more than 13 times (Чичеров 1965: 137).

Goldstone rightly notes that "almost all of Europe's early technical achievements were inspired by a desire to catch up to superior Asian technology. Whether in the production of steel, cotton cloth, ceramics, ships, or even cast iron, in 1500 Europeans could only dream of producing goods that would approximate Asian quality. Efforts to realize those dreams eventually led to machines and inventions that allowed Europeans to catch and eventually surpass Asian achievements" (Goldstone 2009a: 171). Western European countries (especially Britain) sought to what is today called import substitution. Import substitution had important implications in the framework of intra-European trade, because, due to the doctrine of mercantilism and the propagation of the idea of the so-called "emulation" (that is, the desire to catch up with others or surpass them in the development of certain economic advances), more and more countries developed their own industries (Reinert 2007). Import substitution of manufactured goods from Asia became a major source of technological growth.

Accumulation of Scientific and Practical Knowledge Striving for success and wealth was highly correlated with the desire to create more knowledge, which significantly manifested itself in Europe during the Renaissance. However, in this regard, by the Early Modern Period the Confucian countries were well ahead of Europe, as there the tradition of accumulation, systematization, and increasing knowledge was very strong.

Growth of literacy in North-Eastern Europe (see, for example, Allen 2009, as well as Appendix B below) was greatly supported by the increase in the production of books in the period in question, the growth of, the need for knowledge, and the rise of Protestantism (see Appendix B for more details). So during this period of emergence and the strengthening of Protestantism in Europe with 500 million copies of the Bible being printed (Назарчук 2006: 79)—an incredible number in comparison with the previous manuscript technologies. However, the growth of literacy had a variety of consequences. In particular, it is possible to trace the

[20] For example, in the first half of the eighteenth century, the ratio between goods and silver carried on the British vessels that traded with China (Port of Guangzhou) was 10–90 %, or at best 75–25 % (Симоновская and Юрьев 1974: 175; see also Чичеров 1965: 135. 139; Петров 1986: 171; Goldstone 2013).

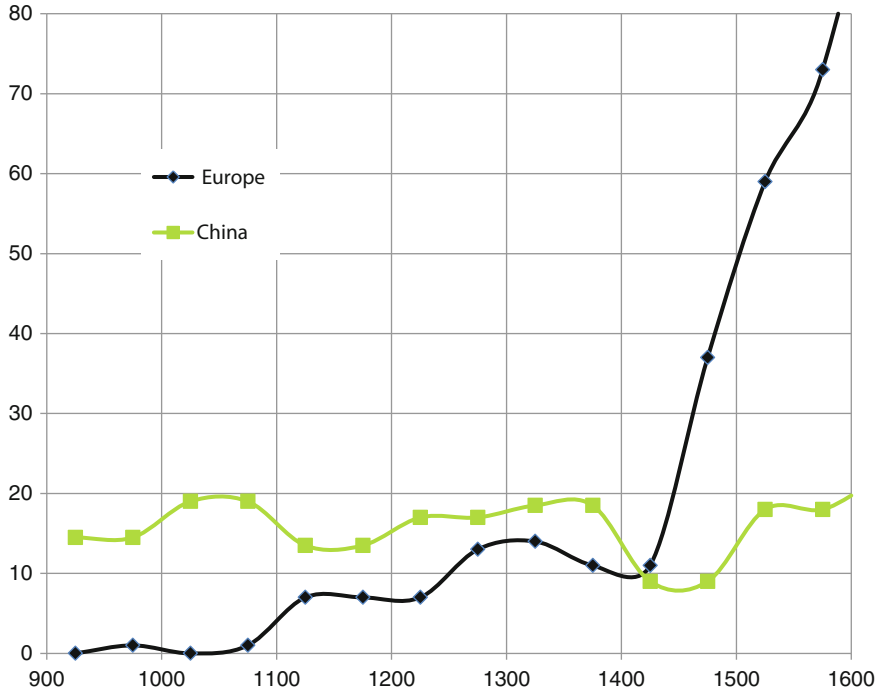


Fig. 2.6 Number of innovations in science and technology in Europe and China per half a century, 900–1600 CE. *Data sources*: Hellemans and Bunch (1988) and Goldstone (2009a: 122)

following positive nonlinear feedback: the growth of education—the increase in volume and effectiveness of special technical literature—the increase in the use of new technologies—production growth—growth of resources spent on the development of education—accelerated development of the education system, and so on. Thus, from a given moment the factor of literacy became an important factor in the growth of production in general.

The growth of science and mathematics in Europe in this period is very well-known (e.g., Singer 1941; Goldstone 2009a, and also Figs. 2.6 and 2.7). Already by the seventeenth century, hydropower development, engineering and ballistics were firmly based on scientific achievements (see also Рейснер 1986: 225).

It has been shown that the invention of the steam engines by Denis Papin and Thomas Newcomen had a direct connection with the achievements of science (e.g., Allen 2009). On the other hand, the demand for precise scientific devices and instruments substantially advanced technological development, promoting the use of techniques used for the production of scientific instruments in industrial engineering (see Рейснер 1986: 228–230; Goldstone 2009a; Mokyr 2002).

Innovation Diffusion Rate in Europe As is well known the Taagepera—Kremer mathematical model of global technological and demographic development is based

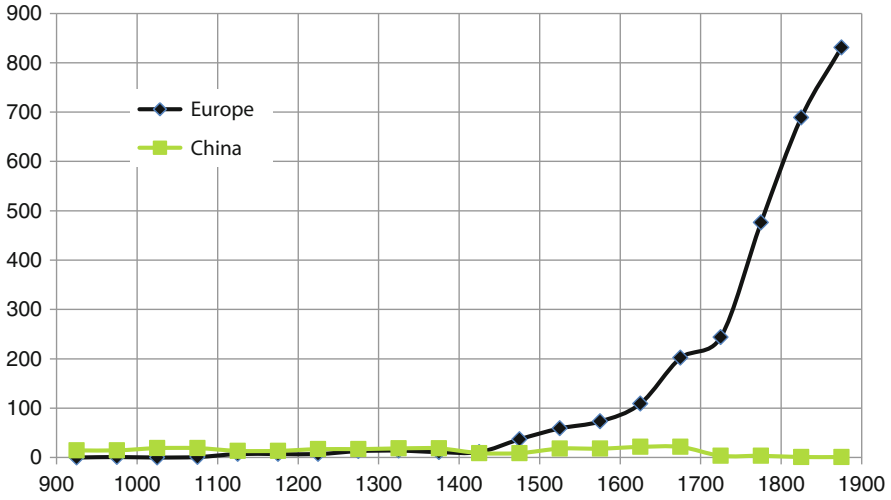


Fig. 2.7 Number of innovations in science and technology in Europe and China per half a century, 900–1900 CE. *Data sources*: Hellemans and Bunch (1988) and Goldstone (2009a: 122)

on the assumption that "high population spurs technological change because it increases the number of potential inventors…—all else equal, each person's chance of inventing something is independent of population—thus, in a larger population there will be proportionally more people lucky or smart enough to come up with new ideas" (Kremer 1993: 685; see also Taagepera 1976, 1979, 2014; Tsirel 2004; Korotayev et al. 2006a; Korotayev 2005, 2006, 2007, 2008, 2009, 2012).

It adequately describes the dynamics of the process of growth at the World System level, while the adequacy of applying this idea to individual societies is a subject of some debate. But in relation to individual societies it appears rather clear that the more a society contacts with other societies, the more actively it accumulates innovations from the outside, and the faster it respectively grows. In any case, the increase in the external activity of the European countries led to a very rapid increase in the accumulation of innovations.

Therefore, we can talk about the rule, according to which the more contacts a society has and the greater their diversity is, the more innovation occurs in those well connected societies.

This is even more relevant for the contacts within Europe itself. Here you can talk about the *competition of peers*, which was not found in the most advanced parts of Asia, particularly in the Far East, since there was mostly a struggle there with the "barbarians". Competition of peers is the most powerful engine of development.[21] It is thanks to this that there were such phenomena as protectionism and Mercantilism that contributed greatly to industrial and commercial development of Europe

[21] This was observed by Eric Jones (1987) and David Landes (1998, 2006) and some other scholars.

(e.g., Reinert 2007), there were military technologies, methods of government, literacy development and the introduction of new laws. In conjunction with the abovementioned abundance of contacts and the dissemination of knowledge and discovery, it is easy to understand that the engine of development worked in Europe much faster than in Asia. The speed of diffusion of innovation in Europe was significantly higher than in Asia. Perhaps within such an Eastern society as China innovations (due to political centralization and other achievements) could spread fairly quickly, but one cannot see any acceleration of the diffusion of innovations among Asian and North African countries in the Early Modern Period. In general, these rates remained the same as in many centuries before (see Fig. 2.6). Moreover, differences in the rate of diffusion of innovations in the European societies, on the one hand, and in the Asian societies, on the other, were already apparent in the Late Middle Ages (see Fig. 2.7), which was additionally explained by a greater peer-polity competition that was typical for Western Europe.

If we take the example of the development of firearms and protective devices against them, then we will see that, according to McNeill (1982), first guns appeared almost simultaneously in Europe and Asia (the first evidence relates to 1326 and 1332). It is possible that the Europeans borrowed not only gunpowder, but the idea of guns from China. However, in the second half of the fifteenth century Europeans overtook the rest of the world in all that is concerned with the technology of guns (McNeill 1982). It is important to note that in the last third of the fifteenth century as a result of the wars of France and Burgundy major improvements in artillery were achieved (stone balls were replaced by iron ones, calibers and weights of guns were reduced, and, most importantly, the European artillery got wheels and carriages that made artillery much more maneuverable (McNeill 1982).

There is, of course, some exaggeration in the McNeill statement, but there is some hard core of truth in his assertion that, in general, the siege gun scheme that was developed in 1465–1477 in France and Burgundy continued to be used until the 1840s, with only one minor improvement (McNeill 1982; see also Cipolla 1965). Artillery of the Eastern countries lagged far behind. And although in the sixteenth century, following the Turkish example, it was to some extent improved, as a whole the rate of innovation in the development of firearms in the East was much lower, especially in the navy. In this connection, we note, in passing, that the emergence of the early modern European industry in the fifteenth and early sixteenth century was largely due to the first (powder) military revolution. The huge demand for copper for casting bronze guns was a powerful incentive for the development of mining (and mechanization) in Central Europe, including Southern Germany and Bohemia (see, e.g., Бакс 1986; Nef 1987); whereas a growing demand for iron caused a shift to the pig iron casting and construction of the first blast furnaces (Ibid). The second military revolution began in Europe in the late sixteenth century, when one could observe the formation of new highly organized, disciplined, agile, constantly training armies that were capable of fulfilling rigorously the orders of commanders, with a clear interaction of all the branches of the armed forces (McNeill 1982).

It was in the seventeenth century when Turkey lost the ability to wage war on an equal footing with European countries. Thus, starting already from the seventeenth century, and especially in the eighteenth century there was no army in the East to face the European armies (this is confirmed by numerous victories of the Russian army over the Turkish armies in the eighteenth century, by victories of European-trained and equipped armies, consisting of native soldiers led by European officers of the East India companies in Java and India, and the famous Egyptian campaign of Napoleon). Meanwhile, the development of military technologies and methods of organization at all times was a very important source of growth and innovation.

Thus, the process of divergence was particularly pronounced as regards the development of military technology and organization; it appears possible to compare its speed only with the matching speed of development of divergence in the domain of scientific knowledge. It is also important that military divergence was a pan-European phenomenon (and not a purely British one).

Continuous Changes in the West At the end of this section, we would like to point out that many of the lines of change in Europe, which emerged in the late Middle Ages, can be traced continuously through the Early Modern Period. And some even had a tendency to accelerate. Jack Goldstone rightly notes with respect to the pre-Industrial epoch that "the… important thing to recognize about… technological and organizational changes is that they were widely scattered over space and time and tended to be isolated, rather than generating continuous and cumulative further change" (Goldstone 2009a: 27). In addition, after their emergence the traditional system of knowledge could decline or stagnate for long periods of time. In Goldstone's view, "the best way to describe technological innovation and change before 1800 is to say that it was sporadic—different technologies were developed at different times and in different places and then not developed much further if at all" (Goldstone 2009a: 28–29).

We see more or less clear lines of development of agricultural technologies and technologies of governance in China, that is the development of such technologies that were most important to maintain stability and prosperity in a supercomplex agrarian empire (see, e.g., Wright 2001; Korotayev et al. 2006b; Гринин 2010). At the same time, China and other Eastern societies knew many technologies and had good opportunities to develop them further, but they did not have such a need.[22] And Europe, as we have seen, had. We can take many lines of technological development in Europe to see this. For example, the development of shipbuilding and ship navigation gives us a continuous line of improvements. The same applies to optical devices, military technology in the field of guns and rifles, as well as in the field of fortification, to financial technologies and many others. And what about the continuous development of science? This continuity of many developmental lines also suggests that the rate of technological and common development in Europe was

[22] Thus, having constructed a powerful and advanced navy in the fifteenth century, later China gave up developing it and the Chinese lost the skills of shipbuilding.

accelerating during the Early Modern Period, whereby whole complex sectors of the economy were emerging.

Jack Goldstone rightly notes that "from the early 1600s onward Europe experienced a striking increase in the number of scientific and technological innovations, becoming the world's leading center of technical change" (2009a: 121). Here it still appears necessary to add an important clarification. Our comparative analysis of the dynamics of scientific-technological innovation activities in Europe and China in 1400–1800 (see Figs. 2.6 and 2.7) has demonstrated that the **"striking increase in the number of scientific and technological innovations" in Europe** was observed since the second half of the fifteenth century rather than since the early seventeenth century.

As we can see, the rapidly increasing scientific and technological innovation activity was already observed in the second half of the fifteenth century, and in the sixteenth century Europe outstripped China rather noticeably as regards this very important indicator. However, one should bear in mind the point that we are considering an indicator that measures not the absolute level of scientific and technological development but the rate of this growth. Therefore, it would be wrong to interpret the above picture in the sense that already in the sixteenth century Europe, in terms of its scientific and technological development, was far ahead of China. By 1800, Europe broke very far away from China (and the East in general) as regards the absolute level of scientific and technological development, and with respect to this indicator by the end of the eightteenth century divergence between East and West had already taken place. Thus, starting from the fifteenth century Europe began to catch up with China on different parameters rather quickly but by this time the gap between China and Europe was so great that even after three centuries of a very rapid catch-up development, by 1800, most of Europe was still unable to exceed China as regards characteristic levels of earnings of the population (Allen 2001; Goldstone 2009a; Allen et al. 2005a, 2011).

The following point appears here to be equally important. In the second half of the fifteenth century in Europe the very pattern of scientific and technological growth there radically changed, which earlier was just slightly different from the traditional pattern of scientific and technological growth that was characteristic of complex agrarian civilizations. It was characterized by the predominance of the cyclical component the component of a trend. It is this pattern that was characteristic of Chinese civilization during the period under review, as well as for Europe until the second half of the fifteenth century, when it was replaced by a completely different pattern of constant acceleration of the growth of scientific-technological innovation. However, it is worth recalling that Figs. 2.6 and 2.7 do not depict the dynamics of the **absolute level** of scientific and technological development; rather they depict the dynamics of change in the **growth rate** of this level. Therefore, even what appears in Fig. 2.7 as a certain slowdown in the scientific and technological growth in the first half of the eighteenth century, is a "graphical aberration". Indeed, if, according to Hellemans and Bunch, in 1650–1699 Europe made 202 important inventions and discoveries, in the first half of the eighteenth century they actually

made far more—244. Thus, in the first half of the eighteenth century in Europe there was a very significant acceleration of the growth of scientific and technological innovation, but this is "dwarfed" by even higher rates of acceleration typical of the period 1600–1649 and also for the period 1750–1799. Thus, in the second half of the fifteenth century, Europe moved from a predominantly cyclic pattern of scientific and technological growth (characteristic of pre-modern complex agrarian societies) to modern constantly accelerating scientific and technological growth where the trend component prevails over the cyclical one.

Joel Mokyr notes very correctly that the "the true key to the timing of the Industrial Revolution has to be sought in the scientific revolution of the seventeenth century" (Mokyr 2002: 29). Indeed, the industrial revolution can be considered as quite a logical continuation of the process of the rapid acceleration of scientific and technological innovation observed in Europe since the second half of the fifteenth century, within which the scientific revolution of the seventeenth century played a major role. However, one can look at this process somewhat more broadly. We can say that since the middle of the fifteenth century in Europe one can observe a transition to a trajectory of modern scientific and technological growth that by the nineteenth century prepared Europe to the transition to the trajectory of modern economic growth. The "small" scientific-technological divergence between the East and the West that took place in *c*. 1450–1800 largely produced the Great Divergence of the nineteenth century.

Thus, the point that science and technology were developing in Europe since the second half of the fifteenth century in a rather stable and progressive way appears to support our idea about catching up divergence as well as the idea that the Industrial Revolution started in Europe since the late fifteenth century, whereas its final and most important phase was realized in 1760–1830 in Britain, and then in the other Western countries. In addition, on the whole, one could observe in Western Europe (and in Britain and the Netherlands in particular) the strengthening of the commercial spirit that infected all levels of society, even monarchs (e.g., Elizabeth of England). It seems enough to read some books of that time, especially in English (for example, works of Defoe or Swift) to feel this. It is not accidental that the doctrine of mercantilism emerged in the seventeenth century, whereas European monarchs became sure that trade and industry served as main sources of wealth for the state. In the eighteenth century almost all the European monarchs cared more about commerce and industry, and it was a common vector of European development. For example, the entire foreign policy of Peter the Great (the roots of which can be traced in the reign of Ivan the Terrible in the 1560s–1580s) was aimed at getting access to the sea for the expansion of trade. Though in the East one could also find a lot of enterprising people, yet the general vector toward commercialization of the life in Europe was much stronger.

Next we look at the industrial revolution, which ultimately transformed the process of "catching up divergence" into the Great Divergence.

Industrial Revolution and Its Three Phases

Why Does It Make Sense to Consider the Industrial Revolution as a Long-Term Process?

Huge changes associated with the transition to the machines and steam power attracted the attention of researchers since the late eighteenth century. But a systematic study of the Industrial Revolution took place nearer to the end of the nineteenth century, possibly with the works of Arnold Toynbee[23] (1927 [1884], 1956 [1884]).[24]

However, as we have already mentioned above, since the 1930s, it became clear that the process of rapid technological innovation began several centuries earlier. This raises such questions as:

– How can we date the beginning of the Industrial Revolution?
– How can we treat the enormous changes that took place in Europe since the fifteenth century (and even before)?

We do not think those developments were not different from the one that took place in the Early Modern Period in the East in essence. At the same time it is clear that the period of technological change that started in the 1760s, compared to the previous centuries, was exceptional by a number of parameters.

That is why we believe it is much more reasonable to consider the Industrial Revolution as a rather long-term process that started in the late fifteenth century and continued till the mid-nineteenth century.[25]

This process went through several phases, and, in our understanding, the last third of the eighteenth and the first third of the nineteenth century (this period is traditionally denoted as the period of the "Industrial Revolution") is only the final phase of the Industrial Revolution, at which irreversible transition to machine technology and at the same time to a new kind of energy occurred. But it was the most prominent and visible phase of the industrial revolution.

Based on this, *we consider the industrial revolution as a process of active development of technology, especially designed to save labor in different areas, the most important of which was the mechanization of manual labor in manufacturing, which*

[23] Not to be mixed with his nephew, the famous British historian Arnold Joseph Toynbee (1889–1975).

[24] However, today assumption is that the term "industrial revolution" (*la révolution industrielle*) was introduced as early as in 1837 by the French economist Jerome-Adolphe Blanqui to describe the social and technological transformation that had occurred in Britain within the previous decades (Mokyr 1999: 4).

[25] For example, in the sixteenth century, the average tonnage of ships increased tenfold in comparison with the fifteenth century (Чистозвонов 1991: 15).

led to a shift from manual labor to machine labor and replacement of biological energy with abiotic energy (water first, and then steam).[26]

Thus, most phases of industrial revolution took place within this period, which in this book is called as the period of catching-up divergence, whereas its completion occurred at the beginning of the era of the Great Divergence. To distinguish between the terms, we will denote the period of the last third of the eighteenth century and the first third of the nineteenth century as the final (machine) phase of the Industrial Revolution.

Within this approach, the significance of the technological breakthrough that began in the 1760s is not underestimated, but at the same time, this breakthrough does not look so unexpected and sudden, as sometimes seems. Many researchers had to move the time of the start of the Industrial Revolution far back in order to take into account the organic connection between the Industrial Revolution of the eighteenth century and the previous transformations. For example, Clark (2007), having considered some of the views on the causes of the Industrial Revolution in Britain, further writes that the Industrial Revolution did not mean a sudden start, it was rather a continuation and acceleration of a process that began in 1600 and afterwards went faster, then slower, then faster again.[27]

We agree with this, but we believe that it is more logical to say that the industrial breakthrough of the eighteenth century is the final phase of the Industrial Revolution, which began in Europe in the late fifteenth century (in England it started a little later, but much earlier than 1600). Allen (2009) writes that the Industrial Revolution can be seen as a continuation of the first phase of globalization. If this is the case then it is logical to imagine the period of early modern history as the period of the Industrial Revolution, this being based on the basis of a number of primary globalization and other processes. Below, we will return to the question of why the final phase of the Industrial Revolution began precisely in Britain. However, for us it is clear that it is only a part of the general question of the causes of Europe's leadership in the Modern Period.

It makes sense to discuss how to treat the Industrial Revolution: as the period, which resulted in a complete change of technological ways, or as a period, which resulted in the development of new technologies, but not in their absolute domination. In this study, this is quite an important issue. Thus, even in 1850 new industries accounted for only a small part of the British economy, and in 1800, the woolen

[26] Note also, that, according to Wrigley (1988), the industrial revolution is a transition from the organic economy (energy resource) to inorganic, from organic production to inorganic one (that is from the agrarian production with its usage of land, plants and animals to the usage of mineral resources). Wrigley implied steam energy, yet, generally speaking, water energy also refers to inorganic energy resources (as we will further show just this energy resource promoted the machinery phase of the industrial revolution in the USA). Thus, already from the fifteenth century, we observe an obvious transition to inorganic energy resources and during the subsequent centuries the distribution of these energy resources proceeded at impressive rates.

[27] A bit earlier he also notes that the industrial revolution extended over 100 years and represented a gradual evolutionary process (Clark 2007: 232, 239), although unfortunately, he does not denote any landmarks in this process.

industry in terms of consumption of raw materials exceeded the cotton industry by a factor of two (see Goldstone 2009a: 125–126).

We believe that the Industrial Revolution is a major macrosocial transformation, but this transformation was first of all qualitative rather than quantitative; its main result was expressed in the formation of a certain sector, in the emergence of a certain model of the economy, which provided a new perspective as regards the use of new resources, increasing productivity of labor etc. But quantitatively the Industrial Revolution did not produce dramatic changes immediately. It only opened up the way to them.[28]

However, the most dramatic changes occurred after the Industrial Revolution. Thus, in theory, on the one hand, we should single out a period of very important quality (innovation) changes that affected only certain sectors of the economy; this would be the period of the industrial breakthrough. But, on the other hand, we should single out a "post-revolutionary period", when the innovations with important modifications and improvements begin their expansion (≈ period of expansion of innovations).

The concept of the Great Divergence of the California School as a sudden sharp change in the vector of the entire preceding development arose from the observation that the modern type of economic growth and a fundamental divergence in living standards between Britain and the countries of the East only developed in the nineteenth century. Hence there emerged the assertion that Britain (and even more so the rest of Europe that lagged behind Britain in the eighteenth century) as a whole was not so different from the Eastern societies. Of course, much depends on what is meant by the Industrial Revolution (Goldstone 2009a: 123). And also of course, "if the term 'Industrial Revolution' is taken to mean 'a rise in living standards to higher levels than anything seen in previous world history,' then no such thing occurred before 1850" (Ibidem).

Actually, a number of researchers date the Industrial Revolution to the nineteenth century, but then it turns out that the most important qualitative changes, the beginning of a phase transition in the last third of the eighteenth happened behind the scenes (note the sharp spurt in innovation in Britain compared to other European countries precisely during this period in the figures in Appendix A). The same applies to the type of economic growth associated with the Industrial Revolution.[29]

However, the rising standard of living, and the transition to a new type of economic growth, according to our understanding, is already the *result* of the revolution, not the revolution itself. So the changes in the type of economic growth, and

[28] One can take the liberty to draw an analogy between the epoch of revolution and the period from the creation of the first samples of a new seminal invention in an inventor's workshop to the creation of the first working production prototypes. And from this stage there can be a long way to the further large-scale implementation of the invention.

[29] However, we should note that during 300 years (from the sixteenth to the eighteenth century) the Western Europe demonstrated a close to contemporary type of economic growth in the foreign trade averaging to 1.06 % per year (O'Rourke et al. 2010), which provided a basis for a transition to such a type of economic growth.

especially growth in living standards required many decades in order to be manifested in a really explicit way.

It is right that "the Industrial Revolution was something of a slow-motion process, rather than a sudden change" (Goldstone 2009a: 94), and the preparation of the actual industrial-machine breakthrough took centuries. This implied the necessity of a long chain of innovations in technology, science and other areas of life, as well as very large changes in the society.

The Initial Phase of the Industrial Revolution

Preconditions As has already been mentioned, in the twefth to fifteenth centuries technologies started to develop rather actively in Europe, there was a shift to rather complex technological processes, improvements of already known mechanisms as well as some really new breakthrough inventions—like the mechanical clock and spectacles (the general rise of the innovation is clearly visible in Figs. 2.2, 2.3 and 2.6).

Among these achievements one must note a mining hoist driven by a water wheel and a horse haulage of ore, horse-powered drilling machines, the port rotary valve, the fulling-mill, iron smelting, rolling and drawing of nonferrous metals (see Эйххорн et al. 1977; Goff 1988; Lilley 1966, 1976; Blair and Ramsay 1991; Mokyr 2002: 48). Also considerable progress was made in the development of mechanization with a water wheel.[30]

One should also mention various foot or water-driven metalworking lathes, drills, mechanical saws, and so on. In the fourteenth century Europeans began to use the press for the production of paper, which had been used before for the extraction of oil, and in woolen textile production (Lucas 2005). The first mechanical clocks appeared in Europe in the late thirteenth century. But there were also a lot of quite simple labor-saving innovations, such as wheel-borrows.

Inland waterways improved very substantially in the fourteenth century. Water locks with upper and lower gates (Lilley 1976: 189) appeared in the Netherlands in the fourteenth century, and later (in the fifteenth century) they appeared in Italy. Big improvements occurred in the nautical technologies, starting from the thirteenth century with the introduction of the compass (probably borrowed from Byzantium) and modern steering control (see Lilley 1966; about the history of shipbuilding and the ships' role in the economy see Unger 2008). One could also observe the diffusion of the fore-and-aft Lateen sail, which allowed sailing upwind.[31]

[30] Nevertheless, one should make a distinction between "agricultural" mills, which grind grain, and "industrial" mills, which were devoted to what are now commonly thought of as industrial applications, such as fulling of cloth, forging iron, and sharpening tools (Lucas 2005), which were obviously less in number (Ibid.).

[31] It is widely assumed that the Lateen sail was actually adopted from the Arab navigators who used it in the Indian Ocean and brought to the Mediterranean in the ninth century (see, e.g., Шумовский 2010).

All this prepared the technical possibilities for great discoveries, especially after the famous Portuguese Prince Henry the Navigator combined the achievements of Spanish shipbuilders and Arab constructors of dhows, producing the famous caravel—the first complex rigged ship (Russell 2000; Diffie and Winius 1977).

It should be noted that many innovations that emerged in those and the following centuries in Europe took place at different times in China and other Asian countries, some were borrowed directly from there (see above), while other technological changes were invented in Europe (e.g., wheelbarrows and gateways, pig iron, and even matches). The difference, however, was the fact that in Europe, all these generated the technological revolution, and in Asia this did not happen.

Technological Changes During the Early Phase of the Industrial Revolution This phase continued for more than a century and a half: it started in the second third of the fifteenth century and continued till the late sixteenth century. In the second third of the fifteenth century an economic expansion started in Western Europe (Бакс 1986; Ястребицкая 1993a: 74; Эйххорн и др 1977; Сванидзе 1990: 412; Nef 1987; Postan 1987; Jones 1987b), and it grew into the early phase of the Industrial Revolution. The Great Geographical Discoveries made those changes irreversible. During this period (the so-called "long sixteenth century"), the capitalist world-economy developed (Braudel 1973; Wallerstein 1974, 1980, 1988; Arrighi 1994).

Mechanization spread wider and wider through various modifications of the water wheel. It (as well as wind turbines, but to a lesser extent) was already used in a variety of industries (Lilley 1966; Lucas 2005): in fulleries; for grinding oak bark, paint, woad (a plant that was used for the production of the blue dye); in metallurgy (e.g., to secure the air supply), in paper mills, in spinning machines, in sawmills, etc. This dramatic increase of the capacity of machines used for the production of metal parts and to increase the productivity of labor. This contributed to the emergence of metal-cutting lathes for the manufacture of axles, shafts, and propellers (Загорский 1960: 33), which greatly improved opportunities for the development of mechanical engineering (see also Hellemans and Bunch 1988). A significant impetus for technological development was provided (as we have already mentioned) by the change in the nature of European wars. The invention and diffusion of firearms increased sharply the demand for metals, which stimulated greatly the development of new methods for their production and processing (blast furnaces, power hammer, rolling mills, tools for pulling wire and cutting metal and so on (Cameron 1989; Загорский and Загорская 1989; Ламан 1989; King 2005; Nef 1987). The invention of the printing press in the fifteenth century created a new typographic industry (Heaton 1948; Tylecote 2002; Man 2002; King 2005). By the beginning of the sixteenth century in some places, especially in the mining operations, it became possible to speak of a primary, albeit primitive, industry (see, for example, Бакс 1986: 199; Lilley 1976: 189–190; Миткевич 1936: 403–404; Nef 1987). One could also observe the formation of general theoretical concepts of the structure of mechanisms, and even an idea of perpetual motion (see, for example, Орд-Хьюм 1980).

The Industrial Revolution as a Process of Intensive Economy of Labor The Industrial Revolution in the Early Modern Period should be seen as a phenomenon of a much broader plan, rather than just a change in the technical field. Moreover, despite the important and notable technical progress, *at the initial phase of the Industrial Revolution, changes in technology (as regards their results and consequences) were not the most significant*. The most relevant consequences were the ones caused by the transformations in the maritime business, which led to the geographical discoveries, as well as changes in continental and intercontinental trade (see, for example, Braudel 1973). In the Early Modern Period (*c*. 1500–1800) one could observe 1–1.2 % average annual growth of the tonnage of commercial maritime operations. These changes gave rise to the formation of the global World System and the impetus for a breakthrough of the maritime countries of Europe—especially the North-Western Europe (O'Rourke et al. 2010).

But we point out these changes in technology as the most compelling evidence in support of the statement that the Industrial Revolution (its initial phase) began in the very beginning of the Early Modern Period and not in the eighteenth century (when the Industrial Revolution entered its final phase). For if the whole Industrial Revolution was associated with the replacement of manual labor by machines, then retrospectively technology is of particular importance.

If we speak of the Industrial Revolution as a process that started in the late fifteenth century and continued till the early nineteenth century, then the common feature of the whole process can be identified as the **continuous economy of human labor (and energy of animal work) in various fields and forms**. Already at the initial phase of the Industrial Revolution, in addition to improving the productivity of physical labor due to mechanization, specialization, rationalization, there was an economy of biological energy and skilled labor by replacing it with simple labor, both in industry and in commerce, accounting, and other areas. One can only imagine how many hours of scribes' work was saved by the printing press, or how much the development of credit reduced the cost of transportation and protection of money.

Middle Phase of the Industrial Revolution

Some Processes that were Important for Divergence The formation in different locations of specific types of businesses (the colonial economy of Spain, the manufactories of Italy and Flanders, the mechanization of mining in Southern Germany and Bohemia, the trade and shipbuilding industry in the Netherlands, and the agro-industrial complex of England) should be noted as a very important characteristic of the initial phase of the Industrial Revolution. Note also that all of these complexes served the whole of Europe (and even the World System) as a major part of their output was exported. For example, half of all ships built in the Netherlands were exported, whereas in the first half of the seventeenth century this country itself had about 15 thousand ships (Ханке 1976: 106, 109; see also Israel 1995; Roekholt 2004).

Innovations and achievements accumulated within such sectors gradually diffused through a major part of Western Europe. It is not surprising that, due to the mutual borrowing of innovations, in the Western European countries the process of diffusion of new forms of production proceeded along with their constant improvement, but at very different rates. A more complex integrated early capitalist commodity economy with special sectors in industry, mining, fisheries, agriculture, navigation, trade and colonial economy was gradually emerging. This was an important point which increased divergence. In fact, one can speak of a constant strengthening of the exploitation by the West of its world-system periphery (Africa and America) and the emergence of new features in this process.

In the seventeenth and eighteenth centuries, due to the devaluation of silver and attempts by Far Eastern countries to achieve their seclusion from the European influence, there took place the processes of more active penetration of Western trading companies into the Eastern trade and the beginning of direct subordination of certain Asian territories (and at the same time the growth of the colonial economy, trade and the slave trade in Africa (Rich 1980; Masefield 1980).

Of course, the rise of colonialism could not cause the machine phase of the Industrial Revolution by itself, but it amplified the process of the accumulation of capital and enhanced its investment. According to some estimates, the outflow and the transfer of resources from India to Britain for two or three decades before and during the "industrial leap" could provide (in the case of productive application), respectively, almost 20–25 % of the net domestic investment of Britain (Мельянцев 1996: 113).

It is estimated that in the second half of the eighteenth century, the net transfer of resources to Europe from Latin America (excluding smuggling) reached approximately 3 % of their GDP, and for such large countries like India and Indonesia it was 0.6–1.2 % of GDP (Braudel 1985; Chaunu 1984: 273; Maddison 1989: 465; Мельянцев 1996: 126). We note, in passing, that during the period in question the most developed countries of Asia (unlike Europe) did not get any major benefits from their peripheries.

Growth of Industry and Non-agricultural Sector: The English Agro-industrial Complex In the Early Modern Period one could observe in Europe the formation of a new industrial sector, which was already radically different from the traditional pre-Industrial manual craft production. In general, it was still based on manual labor, although for ancillary and secondary operations mechanization was applied more and more widely. The seventeenth century and the first third of the eighteenth century was a period of growth and development of new sectors of the economy until those sectors became leading in some West European societies (the Netherlands and Britain; see below). It should be noted, incidentally, that the meaning of the concept of the Industrial Revolution is the transition from the situation when the dominant sector of the economy was agriculture to the situation when the dominant role was played by industry and other related sectors, especially trade or the commercial sector and agricultural sectors producing raw materials for industry. This transition began to take place from the beginning of the Early Modern Period, and

even earlier, but in the seventeenth century it had already produced very tangible results in the Netherlands, where most of the population was employed in industry, commerce, commercial fishing, and the service sector, and in Britain where a huge part of the population in one way or another was connected with either woolen textile production, or with other industrial and commercial enterprises (see, e.g., Dennison and Simpson 2010: 149).

The diffusion of scattered manufactories and the growth of marketability led to the fact that a very large proportion of people became involved in the process of production of industrial products (Лавровский 1973: 248; Лавровский and Барг 1958: 64; see also Wilson 1980; Аллен 2014: 36, 37). Of course, such agro-industrial complexes emerged in some other countries (e.g., in India, where great quantities of fabrics were manufactured for domestic consumption and for export, and in China, where silk exports were very large throughout history and in some European countries, where flax was produced, etc.). But almost nowhere in the world could we find such a large percentage of the population employed in the agro-industrial sector as in the English woolen industry. Hence, the growth of the non-agricultural sector was observed not only in the cities, in commerce, navigation, fisheries, etc., but also among actual villagers; as a result what could be called the agro-industrial sector (albeit with a persistent predominance of manual labor in the scattered manufactories) emerged.

Thus, according to R. Allen (Allen 2009), in England villagers engaged in non-agricultural sectors even in 1500 accounted for 18 %, and in 1750 they already accounted for 32 % of total population, and in general, urban residents and non-agricultural workers in 1500 constituted 25 % of all the workforce, and by 1750 this figure grew to 55 %.[32]

Growth of Volumes In the seventeenth century and in the first two thirds of the eighteenth century, one could observe in Europe a process of diffusion of new forms of production with their constant improvement. There were a lot of qualitative changes, important improving inventions and discoveries, but as regards their innovative potential, they were less important than the changes in the initial phase.

The Europeans began to extract such great amounts of gold and silver that in the late sixteenth and early seventeenth century, that caused a sharp inflation in many countries in Europe and Asia, the so-called "price revolution" (on some of its consequences see, for example: Литаврина 1972; Barkan and McCarthy 1975; Goldstone 1988; Fisher 1989; North 1994; Braudel and Spooner 1980). Silver mines in Germany, Bohemia, and Hungary that had been of great importance in the earlier period, fell into decay under the influence of competition on the part of the American silver (Бакс 1986, Braudel and Spooner 1980; Tylecote 2002).

[32] Nevertheless, one should note that the non-farm sector of the world's gross volume was primarily concentrated in Asia. According to Allen (2009), in 1750 the bulk of craft production was concentrated in China (33 % of global output) and the Indian subcontinent (25 %). This has two important implications: (1) The main amount of both general GDP and industrial GDP was concentrated mostly in Asian countries. (2) Therefore, as we have pointed out, the primary divergence was at the same time a catching up convergence.

Monetary economy was developing very fast, cash was increasingly displaced from the large-scale commercial operations; one could observe the formation of banks, stock exchanges and insurance companies. Never before trade was conducted at such a huge spatial scale, never before such large areas were dependent on industry, and trade in industrial products had never been greater. First industrial crises happened in relation to changes in technology, discovery of more powerful or cheaper natural resources. Machines were becoming more and more widely-used. Never before one could find such a high concentration of machines and such high labor productivity in industry. Some new industries demonstrated very impressive growth rates and production volumes. For example, in England in 1640 (in comparison with 1540) the production of lead, tin, copper, salt increased by 6–8 times, whereas the production of iron tripled (Лавровский and Барг 1958: 63; see also Tylecote 2002; Allen 2009).

The navigation technologies underwent tremendous changes, which helped to develop strong trade flows. The development proceeded in the direction of continuous improvement of ship design, which, as already mentioned above, can be considered rather efficient machines that were outperforming any machines on the ground. In the fifteenth century, vessels with carrying capacity from 50 to 200 ton prevailed in Europe, whereas in the sixteenth century, one could observe the emergence of giant ships with capacity from 500 to 2,000 tons (Чистозвонов 1991: 15). The development of navigation technologies also resulted in the significant growth of fish production (see Braudel 1981–1984; Чистозвонов 1978: 147; Зингер 1981: 42–43; Kehoe 1992: 243). In fact, we can speak about the formation of a completely unique marine commercial and industrial sector in the Netherlands, including the production of thousands of ships per year, port and transport facilities (with floating docks), fishing and hunting large marine animals, long-distance trade and the maintenance of factories, and all this was closely linked to the financial sector (Boxer 1965; Jones 1996; de Vries and van der Woude 1997; Rietbergen 2002; Israel 1995; Roekholt 2004; Allen 2011).

Some Preconditions and Precursors of the Started Industrial Breakthrough

Deficit of Wood and the Started Transition to a New Energy Type The seventeenth century and the first two thirds of the eighteenth century was a period when the scope and scale of the industrial production principle[33] exceeded everything that had been observed earlier. As a result, on the one hand, it was the time of extensive development, when the use of newly discovered or put into circulation resources was constantly expanding. On the other hand, such an intense consumption of conventional resources led to their deficit in some countries. In particular, the powerful fleets and metallurgy required immense amount of wood. The iron production with charcoal in many cases was beginning to slow down due to the lack of fuel. The

[33] For more details on the "production principle" notion see Grinin (2007, 2012a) and Grinin and Grinin (2013).

production of iron pig required 20–30 large trees per ton (Черноусов et al. 2005: 320). Therefore, in the late seventeenth century, exports of ferrous metals from Sweden reached enormous volumes for that time, that is 30,000 tons (Cameron 1989; Aström 1963; Hall 1980; Wilson 1980). Shipbuilding required timber at an ever increasing scale. The construction of a military sailing ship took up to 400 oak trees. The Invincible Armada cost Spain more than half a million century-old trees (Толстихин 1981: 36). This was most noticeable in the Netherlands and England that were forced to buy wood in large quantities. Thus, half of the physical import of England in the late seventeenth century was wood (Cameron 1989). This situation led to the expansion of trade and such countries and regions, as Poland, the Baltic States, Sweden, Russia and North America got strongly involved in the international division of labor. Several researchers, starting with the work of John Nef (1932; see also Hatcher 1993) call this situation a "timber crisis", although other authors (Flinn 1959, Hammersley 1957) do not agree with this definition, and the findings of a specific study of this issue, conducted by Allen "call into question the theory of the timber crisis as a European-wide phenomenon. There were some timber crises—London was a preeminent example and there are important, analogous situations in the Low Countries. These crises were associated with rapid urban expansion in the early modern period. Elsewhere, however, the price evidence is inconsistent with the timber crisis as a general feature of economic life" (Allen 2003: 470–471).

However, Allen acknowledges a certain shortage of wood in England during the Industrial Revolution (Allen 2003, 2009). And it contributed to a widespread adoption of new types of raw materials and energy sources, including a special role played by coal. It is not surprising that from 1560 to 1680, coal mining in England increased by 14 times, reaching 3 million tons per year (Лавровский and Барг 1958: 63, see also Allen 2009).

The First Economic Crises of the Modern Type Indirect evidence suggesting the emergence of a fundamentally new type of economy (with a peculiar role of complex trade, financial sector and industry) is provided by the data on the first stock exchange and trade crises (Вирт 1877; Hansen 1951; Braudel and Spooner 1980; Craig and Garcia-Iglesias 2010; Гринин and Коротаев 2009в; Гринин 2012). It is important to note that they affected the European economy, and were not only restricted to the national level. In the nineteenth century, the researchers of medium-term cycles and crises often paid considerable attention to the crises of the eighteenth century finding them very instructive, and most importantly—to a large extent similar to the ones they witnessed themselves (see, for example, Вирт 1877). Indeed, the similarities (excitement, excessive lending, unexpected spectacular bankruptcies, credit crunch, and panic) are rather obvious. And it is no coincidence that a number of elements necessary for the emergence of modern economic cycles (of course, except for the system of machine manufacturing that dramatically increased the supply of goods to the market) were already available at that time. The imperative of constant expansion of production had already been formed. Therefore, the cyclicality inherent in the industrial production principle was already rather noticeable. The role of credit had also increased. And since the medium-term

cycles are strongly connected to fluctuations in credit, then a prototype of medium-term cycles (with a characteristic period of about 10 years) could be already traced in the eighteenth century, especially in its second half (Hansen 1951; Вирт 1877; Braudel 1973; Braudel, Spooner 2008; Craig and Garcia-Iglesias 2010).

Emergence of Free Working Hands Changes in agriculture in Europe, the growth of marketability and a tendency to the formation of modern farming are well known, so we do not dwell on them (see, e.g., Trevelyan 1978; Goldstone 1984; Overton 1996; Apostolides et al. 2008). However, we fully agree with Jack Goldstone' opinion that advances and changes in British agriculture observed in the Early Modern Period can hardly be called agrarian revolution, as they were not accompanied by a transition to a fundamentally different labor productivity (Goldstone 2009a: 29–32). Between 1600 and 1750, labor productivity noticeably increased approximately twofold (see Dennison and Simpson 2010: 150, Table 6.2); however, one can hardly compare it with the breakthrough in labor productivity in industry during the Industrial Revolution. On the other hand, one could observe a rather specific and in relative terms extremely large-scale agro-industrial sector; and secondly, it is very important that the increase in productivity and a reduction in the number of hired farm workers (Goldstone 2009a: 30–32) gave rise to the growth of non-agricultural sector in England. On the whole, in the seventeenth and eighteenth centuries, the development of agriculture in Britain was in the general direction of the growing labor-saving, which ultimately promoted the Industrial Revolution by helping to provide the growing non-agricultural population with food and increasing the export earnings of the country, as well as by reducing the number of agricultural workers by one-third (Overton 1996: 82; Goldstone 2009a: 30–32, see also Hill 1955: Chap. 3). Extra working hands emerged in the country; they were not needed in agriculture, and they found their application in industry. According to the calculations carried out already in the nineteenth century by Gibbins (Гиббинс 1898: 147), in the first half of the eighteenth century in Britain, the pure product per person employed in industry was £9 per year, and in agriculture it was £18.3 per year. Consequently, such a situation could (in addition to the level of wages) stimulate the use of machines, because without increasing productivity in industry investment in it turned out to be less profitable than in agriculture.

Final Phase of the Industrial Revolution

The final phase of the Industrial Revolution started in the second third of the eighteenth century in Britain. It resulted in the emergence of machine industry and transition to steam engines. Since the events of this technological breakthrough are well known, we shall not dwell in detail on them. Some details will be discussed in the following paragraphs. We have already said that the essence of the Industrial Revolution can be defined as labor-saving. But the final phase is particularly remarkable as it is associated with the replacement of manual labor by machines. The fastest process of mechanization started in the 1760s and the 1770s, that is,

since the invention of spinning wheel "Jenny" by James Hargreaves and the invention of the apparatus for the mechanical fabrication of yarn by Richard Arkwright. Arkwright created the first spinning mill. Subsequently Arkwright's machine was named *waterframe*. At early stages both machines complemented each other. One should also note that Hargreaves was subjected to harassment for his invention by fellow craftsmen, and Arkwright had to defend his rights in court. Positive decision in his favor opened a wide path for the Industrial Revolution. In the 1770s, Arkwright managed to create a system of machine production of cotton fabric, capable of carrying out all the successive operations of this industry, however, with a very important exception of weaving. But then this problem was resolved either (e.g., Mantoux 1929; Allen 2009). As a result, from 1780 to 1820, the output in the cotton industry increased by more than 16 times (Шемякин 1978: 51). The time of the finalization of the industrial revolution in the cotton industry may be connected with the creation by Richard Roberts of a rather sophisticated mechanical loom in 1822. One can, however, take as such a final point James Smith's invention (in 1834) of a machine that made almost all operations (except for some minor ones) completely automatically. Already in 1834, those machines were installed at 60 spinning mills in Britain with 200,000 spindles (Цейтлин 1940), which illustrates rather well the rapid pace of change in industrial production (see also Payne 1978; Allen 2009; North 2002).

So, for the first time one could observe the emergence of not just a particular mechanized sector (in the Early Modern Period the degree of mechanization in the mining or processing of timber was already high enough (see, for example, Бакс 1986; Райерсон 1963: 207; see also Lucas 2005; Nef 1987; Hall 1980), *but such mechanization became a source of continuous and systematic expansion of the scope of application of machine technology in one related industry after another*. Machine production opened up entirely new opportunities that allowed connecting the production with science and education.

The steam engine, which became a symbol of industrialization, had been created and perfected for over a 150 years, until it became universal. At the beginning of the eighteenth century, an appliance (the famous Newcomen engine) had been used to pump out the mine. Later, it was used for blast furnaces, and then to replace the water wheel in power plants (see Allen 2009 for more details). By the time of the invention of Watt steam engine, there were more than a hundred of such machines in the north of England (Lilley 1966). After the 1770s, one could observe the start of industrial use of already rather effective Watt steam engine, which was continuously improved for a long time. Application of steam engines made people more independent from nature, since it became unnecessary to build factories near water. Steam engines gradually replaced the hydraulic ones. In 1810, there were about five thousand steam engines in Britain, and in 1826 there were 15 thousand (Куликов 1979: 385; Шемякин 1978: 51; see also Crafts 2004; Kanefsky 1979; Allen 2009). A powerful industry emerged—that of mechanical engineering. Its development was also greatly facilitated by the invention (around 1800) of the mechanical slide lathe (Загорский and Загорская 1989: 9; Кирилин 1986: 288; Woodbury 1961; Cantrell and Cookson 2002), that is a unit for mounting and moving the tool in the machine.

Thus, in the final phase of the industrial revolution in Britain, the initial mechanization of textile industry developed in parallel with the invention and implementation of an effective steam engine (Newcomen's engine was extremely inefficient), as well as a powerful expansion of coal mining and steel production. But later, in the early decades of the nineteenth century, these trends merged into a single stream and made the industrial revolution an irresistible process.

Why Britain?

General Factors There are many explanations why in the nineteenth century West Europe (and West European offshoots) managed to outrun the other regions of the world, as well as why the Industrial Revolution took place in Britain. Among the proposed factors that are relevant for West (or North-West) Europe as a whole one can mention a successful institutional protection for competitive markets in land, labor, and intellectual property, respect for property and rule of law (North and Thomas 1973; North 1981; North and Weingast 1989; De Long and Shleifer 1993; La Porta et al. 1997; Acemoglu et al. 2005; Greif 2006; Ménard and Shirley 2008; North et al. 2009; Ferguson 2011; Acemoglu and Robinson 2012), the dominant role of merchants and commercial law in European city-states (Dobb 1963b; Crone 1989; De Long and Shleifer 1993; Mielants 2007; Kuran 2011; Tracy 1997); multiplicity of competing states[34] (Wallerstein 1974, 1980; Mann 1986; Jones 1987a, b; Crone 1989; Sanderson 1995; Christian 2004; Ferguson 2011); peculiar geography with dispersed portfolio of resources and the high proportion of coastlines (Chirot 1985, 1986; Jones 1987a, b; Crone 1989; Sanderson 1995, 1999), rich coal deposits (Pomeranz 2000; Allen 2009), some peculiar climate features (Sanderson 1995, 1999; Crone 1989; Landes 1998, 2006); pre-Industrial European colonial expansion (Sherrat 1995; Pomeranz 2000; Christian 2004), special North-Western European family structure (Jones 1987a, b; Crone 1989: Chapter 8; Allen 2009; De Moor and van Zanden 2010), exceptionally high wages in North-Western Europe (Allen 2009; Rosenthal and Wong 2011); development of modern health care (Armengaud 1976: 28; Ferguson 2011), "Industrious Revolution" (Mathias 1979; de Vries 1994, 2008), and also Scientific Revolution that preceded the Industrial Revolution, in general (Crone 1989: Chapter 8; Inkster 1991; Allen 2009; Goldstone 2009a), and the spread of an industrial Enlightenment, in particular (Mokyr 2002, 2010), Protestant work ethic[35] (Landes 1998; Ferguson 2011), or some other features of Western Christianity (Hall 1985; Mann 1986), the rise of "bourgeois", market-based notions

[34] This is often connected with the point that Medieval West Europe was very effectively shielded from the invasions of the external barbarians in general and the nomadic world in particular (e.g., Crone 1989: 150).

[35] This thesis is often ascribed to Max Weber. Note, however, that Max Weber himself opposed it very strongly: "… however, we have no intention whatever of maintaining such a foolish and doctrinaire thesis as that the spirit of capitalism… could have only arisen as the result of certain effect of the Reformation, or even that capitalism as an economic system is a creation of the Reformation" (Weber 1930 [1904]: 91). Hence, this thesis should be denoted as "pseudo-Weberian" rather than Weberian.

of virtue and success (McCloskey 2007); and even an accumulated genetic advantage in commercial skills among the urban merchant elite[36] (Clark 2007). In the framework of the present study it is impossible to analyze all those opinions, as this would require detailed comments regarding most factors mentioned above (note, however, that we have already made some comment on some of them above). Generally, we agree with Jack Goldstone when he maintains that "there are so many of these features, each one identified as the pivotal factor, that it is hard to credit any of them as being an adequate explanation" (Goldstone 2013: 56). We rather need a systemic analysis which we have tried to perform via our interpretation of the causes of the European breakthrough and the Great Divergence.

The Industrial Revolution as a World-Systemic Phenomenon We believe that we must first talk about the general features of Europe in comparison with Asia, and only then look for specific features of Britain compared with the rest of Europe. At the same time, it appears more productive to proceed from the fact that the explosion of innovation in the late eighteenth century (see Appendix A) was not equal to the Industrial Revolution, it was only a part of it, the final phase; then the continuity of the process and its "relay-race" nature (in particular the integration and development by Britain of many European achievements) become clearer.

Thus, the reasons why the industrial breakthrough of the eighteenth century started in Britain, are not a separate issue; they are rather a continuation of the question about the causes of the Western Europe's leadership in general. The initial phase of the industrial revolution began in Southern Europe, Germany and Flanders,[37] its intermediate phase was undoubtedly linked to the success of the Netherlands, although in England we see in retrospect a very interesting agro-industrial complex. Within this approach, it is clear that the final phase of the Industrial Revolution was to start somewhere in Europe. Therefore, to understand why it took place in Britain in the second half of the eighteenth century, it is necessary to compare it in the first place with its European neighbors, rather than with China or Japan. Such a direct comparison is very useful, but it can hardly answer the question about Britain's evolutionary advantages, as it had already been an evolutionary advantage of the second (rather than the first) order. To prove this, we have made a numerical analysis of the level of technical innovation in Europe from the fifteenth century to the nineteenth century, in Appendix A. The comparison between Britain and its European neighbors with respect to this indicator shows rather clearly that the separation of Britain from other European countries became more or less distinct only in the second half of the seventeenth century (before that time Britain tended to lag behind Italy, Germany, France, and the Netherlands). Thus, it is clear that Britain during the first two centuries of the Industrial Revolution absorbed the achievements of other European societies, and only later it became capable to start its own innovative climbing. This British lead gradually increased until it reached its

[36] Note that Jack Goldstone (2007) convincingly proved the irrelevance of this factor.

[37] However, later it involved the other European countries due the fast diffusion of innovations, the formation of the European market and maturing globalization.

apogee in the second half of the eighteenth century. But this advantage could not continue for too long. Already in the first decades of the nineteenth century, it became clear that some other European countries and the United States were trying rather successfully to catch up with England, and in the second half of the nineteenth century (from the 1860s) England ceased to be a leader and its role in invention decreased from decade to decade (see Appendix A for more details).

In other words, the industrial revolution should be regarded as a global phenomenon one of whose phases began in Britain. Obviously, since the industrial revolution had already started and was going on for two and a half centuries, it was supposed to end somewhere. Britain had the best conditions for this. But if not Britain, then after a while it would have been a different place, like Belgium, for example. This can be compared with the Information Revolution of the 1940s and 1950s. It started in the United States, but hardly anyone doubts that, if not in the United States, then it would have started later elsewhere.

Thus, if there is something miraculous in the emergence of the Industrial Revolution in Britain, it is an ordinary "evolutionary miracle", the miracle of the transition to a new level of complexity—as a result of the fact that all the necessary conditions emerged, whereas those conditions had been prepared in different places and during a long period of time—it is a success that could only happen after previous partial failures and numerous lessons learned. But the industrial revolution could develop only because it was a world-systemic phenomenon. It absolutely needed a wide market, which was, in fact, the whole world.

Indirect evidence of this is the fact that all the British economic crises of the first half of the nineteenth century, associated primarily with the deterioration of export opportunities for fabrics, notwithstanding the fact that government and business owners made enormous efforts for the development of export—up to giving large credits to potential buyers (Туган-Барановский 2008[1913]; Tooke 1838–1857; Juglar 1889; Tugan-Baranovsky 1954; Вирт 1877; see also Minsky 2005; Kindleberger and Aliber 2005; Payne 1978; Craig and Garcia-Iglesias 2010; Bulter-Thomas 1994; Гринин and Коротаев 2009в, 2010; Grinin 2012a). On the other hand, the development of industrial economy could proceed only with the expansion of food imports from the periphery.

Peculiarities of Britain If we consider the reasons directly attributable to Britain, then we can immediately point out some political and economic reasons. Britain benefited from the religious wars in Europe in the sixteenth century (because they stimulated the migration of skilled craftsmen from the continent); it also benefited from the Great Geographical Discoveries, as it received a lot of American silver and founded its own colonies. The British were able to defeat their main commercial rival (the Netherlands), which gave a powerful impetus to maritime trade. The basis for capitalism in Britain was wider than in other countries, because one way or another it embraced the bulk of the population.

In contrast to the French nobility, the English gentry never considered commerce as a sort of defamatory occupation and actively participated in it. Everywhere In the Middle Ages ownership of land and/or service to a sovereign were more honorable

than trade, but, for example, the role of trade in China was also belittled ideologically (Мугрузин 1986). Note that among European countries there were significant differences in the prestige of commercial occupations. In France, for a noble the occupation "of industry or commerce was considered dishonorable. A nobleman engaged in it was expelled from his class" (Гордон and Поршнев 1972: 262), whereas in England this was quite a decent occupation. Trevelyan (1978) notes that England escaped a sharp division into a strictly closed caste of nobility and unprivileged bourgeoisie. And that is one more reason why Britain and not France became the birthplace of the Industrial Revolution. This resulted in less parasitism of the ruling class and the growth of investment in British economy (see, for example, Trevelyan 1978). Since the late fifteenth century, after the introduction of prohibitive export taxes on wool by Henry VII one can speak about rather sound economic policies of England, which also contributed to the growth of its manufacturing industry and wealth (see Reinert 2007 for more details).

But in general, it is important to bear in mind that here the reasons were acting as a complex set that created a chain of events, each link of which determined subsequent links. So, how important was the emigration of Huguenot craftsmen (specializing in cotton manufacturing) from France to England in the late seventeenth century?[38] How important was the point that the British cotton industry developed under the auspices of prohibitive tariffs and outright bans on the import of Indian printed fabrics?

Note that these were woolen and silk fabric traders who were initiators of the introduction of such bans (Mantoux 1929; Чичеров 1965; Allen 2009). Of course, not only this eventuality was required to initiate the industrial breakthrough. And yet, the British textile industry rise could hardly have happened, if the import of Indian fabrics had not been banned.[39]

But this was an ordinary protectionist measure (a lot of them were practiced in Mercantilist Europe of that time). On the other hand, if in England loopholes had been left for the production of its own cotton fabrics (as this happened in France as a result of Colbert's prohibition in 1681), the British cotton textile industry could not have risen either. Meanwhile, we believe it is very remarkable that the Industrial Revolution began in England in a new (cotton) industry, as in the old (wool) industry, it could not start because of the conservatism of the organization of the latter (Цейтлин 1940; Шейпак 2009).

Thus, in explaining the reasons why Britain was the birthplace of the Industrial Revolution machine phase, we should take into account the combination of many historical contingencies and peculiar features of the British economy. Of course,

[38] The first wave of this migration was caused by the ban of cotton fabric production in France, whereas the second wave was produced by the abolition of the Edict of Nantes.

[39] As has already been mentioned, the importation of such fabrics increased enormously. Hence, it is not surprising that the woolen and silk traders struggled to impose such restrictions, whereas the process of introduction and raising the import customs began already since 1660; however, the importation of the Indian fabrics continued to grow (Чичеров 1965: 141; Allen 2009), which necessitated the introduction of the total ban of those imports.

they should be regarded as a system, because, without even a single element, the total could be significantly different. Allen is right when he stresses that to understand the causes of technological breakthroughs we need to study closer the technological development and not get carried away with talk of constitutions (Allen 2009), although here he underestimates the general conditions of development, without which there can be no technological breakthrough. But on the other hand, among the many reasons there are those without which the industrial breakthrough clearly could not have happened. And we will pay our special attention to them.

Peculiarities of Natural Conditions of Britain and the Role of Steam Power in the Industrial Revolution Sure, the important role was played by the presence of large reserves of coal in England and lower prices for it (a number of researchers draw attention to this point, including Pomeranz 2000; Allen 2009; Goldstone 2009a).

It is difficult to overestimate the role of coal, as well as the one of emergence of efficient steam engines. However, it is recognized that the Industrial Revolution began in the textile industry and in principle it could develop for a long period of time without coal. In 1750, in Britain, according to some sources, hydraulic motors used in industry had a total capacity of about 65 thousand horsepower (Goldstone 2009a: 164), is not so little to start the industrial breakthrough. For comparison, one may note that even in 1850 the total capacity of steam engines used in the British cotton plants was only 71 thousand horsepower (Lilley 1966). The first steam engine in the cotton industry appeared only in 1785 (Allen 2009), when the mechanization of the industry was in full swing. Even by 1800, the number of steam engines was almost four times less than the number of hydraulic ones (Allen 2009), and the bulk of the steam engines was used in mining and other (non-textile) industries.[40] On the other hand, without the steam engine and coal, the momentum of the Industrial Revolution, which began in the cotton industry, would have been much weaker; the same is true as regards opportunities to borrow its technologies, not to mention the fact that the revolution in transport might just not have happened. You can draw a parallel with the start of the Industrial Revolution in Europe in the last third of the fifteenth century. That rise had nothing to do with the Great Geographical Discoveries, but without them it would be much weaker and could die out soon.

We must agree with the main idea of Allen, that the appearance of the steam engine, the spinning and weaving machine was explained by the specific economic conditions of Britain (cheap coal and expensive labor in particular). This is precisely what happens: a global breakthrough occurs under specific conditions of a particular time and location.

However, one can hardly agree with his statement that the British success was based on the technological innovations adapted to the country's situation and useless beyond its borders (Allen 2009). Actually, further in his description he contradicts this statement himself. The introduction of new technologies was delayed in

[40] Even in 1850 the total power of the hydraulic engines in the cotton industry was 11,000 hp or approximately 13 % of the total power of all the engines (Lilley 1966).

Europe not due to the lack of cheap coal there and not due to cheap labour force (actually, it was not that cheap) but due to complicated social circumstances (including guild restrictions which were absent in Britain but were strong in Germany and other countries), rather narrow sale market and an inflow of English goods which were difficult to compete with as well as the protection of works secrets in Britain (Allen himself gives a number of examples of prosecution of those who tried to export technologies; see Allen 2009). If the technologies were useless in Europe why protect them and forbid the qualified workers to leave the country? Also the development of cotton industry proceeded at a rather fast pace. At the same time, as we will see further, the cotton industry also developed rather fast in the USA although without introduction of the steam engine. Besides, in spheres where technologies were really needed, as in transportation, the expensive coal was not an issue, after all, the steamer was invented in the USA. Meanwhile, in Europe the railway construction developed rather quickly and did not lag behind Britain. This supports the idea that the English machine revolution was a part of the long European industrial revolution. Thus, although the industrial revolution had started in Britain which in certain respects surpassed other European countries, the latter were quite prepared to quickly adopt and develop technologies.

Development of Technologies, Population Growth, and Living Standards Some researchers regard the exceptionally high wages in northwestern Europe as a very important factor (Allen 2009; Rosenthal and Wong 2011; Ferguson 2011). Relatively high wages (see Allen 2009 for more details) made investment in labor-saving technologies rather profitable.

As research by Allen, Clark and their colleagues (Allen 2001, 2007, 2009, 2011; Allen et al. 2005a, b, 2011; Clark 2001, 2003, 2005, 2007) suggests, in the second half of the eighteenth century, real wages in Britain and the Netherlands were the highest both in Europe and in the world (but by the early nineteenth century, the Dutch real wages fell slightly below the British). In the fifteenth century, wages in Europe were about equally high in different countries, but then in countries such as Austria and Italy their very marked decline took place. In Britain and the Netherlands in 1725–1800 they also somewhat declined, but not as much as in the rest of the world, and at the beginning of the nineteenth century, real wages in Britain (although they did not exceed the maximum of the fifteenth century) were the highest of all the countries, for which have necessary data at our disposal; while in nominal terms (in grams of silver without taking into account purchasing power parities) average wages in London were in 1800, almost one and a half times higher than in Amsterdam, and several times as high as in Vienna, Florence, Beijing or Delhi. They have shown that the assertion that the British workers of the Industrial Revolution era were very poor, did not correspond to reality; at the same time in most European countries (including Italy, Austria and Germany) the level of wages in the eighteenth century was quite comparable to the salaries in advanced areas of China and India. However, all recognize the fact that until the nineteenth century, wages and in England did not beat up the fifteenth century maximum.

As Goldstone notes, "the single most important fact is that there is no evidence of any significant rise in material living standards for average workers in any societies before 1830" (Goldstone 2007: 208); however, on the other hand, "it is certainly true that Britain had higher wages and lower capital costs than France, and even more so than China" (Goldstone 2011).[41]

It is quite obvious that, although the labor price in England at the end of the eighteenth century did not exceed the maximum of the fifteenth century, still labor there by world standards, was very expensive, which facilitated its replacement with machines. In addition, it is well known that after the invention of Kay's loom in 1733 spinning technologies were not developing as fast as the weaving technologies, which resulted in a high demand for yarn. And the constant attempts to invent productive spinning machines were really caused by the deficit of yarn and yarn spinners' labor (Mantoux 1929; Цейтлин 1940).

Legal System and Patent Law At the end of this section we will discuss the point, which is rarely discussed among the followers of the California School.[42] It is associated with an explanation of an indisputable fact, namely the spirit of innovation in Britain that increased dramatically in the seventeenth and eighteenth centuries, (see, for example, Goldstone 2009a). The reasons for this cannot be reduced to a single cause; but among a number of such reasons, it is important not to forget about the institute of intellectual property that was developing in Europe, and, especially, in Britain. More specifically, it is a question of the patent law, in which England was in the lead as early as in the seventeenth century, although the beginning of the technical patenting was laid much earlier. Note that no state will initiate special acts concerning the rights to technical invention, if there are not enough cases of actual inventions, if there are not enough legal disputes over the right for the use of such inventions. Britain, of course, often had problems with the protection of patents from perpetrators of inventors' rights since the adoption of these acts (Dutton 1984; Khan and Sokoloff 1998), but these were already fundamentally different legal cases in comparison with the earlier situation when the rights of inventors were not protected at all (see, e.g., Dutton 1984; MacLeod 1988; MacLeod and Nuvolari 2007).

There are discussions around how those laws contributed to the rise of innovative activities (see Mokyr 2002; MacLeod 2009 for a review). Several authors believe that the importance of patents for economic development in general and for British industrialization in particular was really significant (North and Thomas 1973:

[41] Bishnupriya Gupta and Debin Ma arrive at rather similar conclusions: "Chinese real wages were far behind those in London or Amsterdam—only about 30–40 % of earning levels there in terms of purchasing power… Unskilled laborers in the major cities of China and Japan—poor as they were—had roughly the same standard of living as their counterparts in central and southern Europe for the larger part of the eighteenth century" (Gupta and Ma 2010: 272), whereas Mokyr notes that "high real wages may simply have reflected higher output per worker, not a cost disadvantage to labor utilization that was absent elsewhere" (Mokyr 2010: 270–271).

[42] However, a very much attention is paid to this point by the institutionalist economic historians (North and Thomas 1973: 155–156; North 1981: 164–166; Chang 2001).

pp. 155–156; also North 1981: 164–166, Chang 2001). Objections to their significant influence are reduced to the fact that the actual inventors who created the basis for the industrial breakthrough in the second half of the eighteenth century and the early nineteenth century tended to get very little; they did not become very rich men, and sometimes they got almost nothing for their inventions (see, for example, Clark 2007: 234–238). But even in the USA today, the share of income from inventions retained by the inventor is only slightly more than 2 % (Mokyr and Foth 2010). The second objection is that the patent laws were rather awkward and to obtain a patent was quite expensive, so they were not so effective to significantly stimulate innovators and reliably protect their rights (MacLeod and Nuvolari 2007). However, it is clear that medieval laws, although they were less effective than today, in general, were quite consistent with the general level of the legal system, the rhythm of life and the number of inventions (which was not comparable to the present-day number at all). The third objection is that the law on monopolies was enacted in the early seventeenth century, and the final phase of the industrial revolution began only a century and a half later, which apparently implies the absence of a direct connection between the events. On the other hand, for a stream of innovations to emerge it was necessary that a need to obtain patents for inventions (together with a hope to obtain some profit for one's invention) would become widespread, and this could only be achieved in many decades of operation of the respective institution.

History of patent law begins with the privileges of the invention, which appeared by the end of the Middle Ages, which were issued at the request of the monarch and were monopolies granted to specific persons or companies (but not necessarily to inventors themselves). Already in the thirteenth and fourteenth centuries so-called "open letters" (*Letters Patent*) were issued; through them monarchs granted special privileges to those who implemented new technologies; by the way, it was not necessary to be an actual inventor of such a technology to obtain such a letter. Often these privileges were given to immigrants. Such a person received the exclusive right to use a respective technology for a period sufficient to enable the assimilation of this technology (see, for example, Михайлов 2007). Examples of such documents can be found in Hulme 1909. It is believed that the world's first patent was issued in 1421 by the City Government of Florence in the name of Filippo Brunelleschi, who invented the ship's crane. Another very old patent was granted by the English King Henry VI in 1449 to a native of Flanders John for the manufacture of stained glass for the windows of Eton College (Близнец 2001). But these were still *Letters Patent*.

Patents in the modern sense of the word appeared in the late fifteenth century in the Venetian Republic (Machlup and Penrose 1950, Мокир 2012: 74). In 1474, a decree was issued, according to which Venetians were to inform the Republican authorities of the inventions implemented in practice. The patent term was 10 years; it was issued by the Doge on the recommendation of the Republican Council. One of the purposes of these privileges was the liberation of the inventor of the control of the guilds. It is known that in 1594, Galileo received a patent of Venice for a new design of the water pump. Thus, the patent laws emerged in different countries of Europe in the late Middle Ages and reached a high enough level in the fifteenth and

sixteenth centuries in the Italian states. However, in England it continued to develop. Experts in the field of English law (including the famous W. S. Holdsworth, the author of the 17 volume *History of English Law*) believe that the moment from which originated the current patent law is the sixteenth century [during the reign of Henry VIII, or a little later (see, for example, Моллаева 1993)]. Open letters were replaced by new documents—royal charters *Crown negotiating* (Hulme 1909).[43]

These charters were widely used to attract skilled foreigners, and the legal form itself is most likely to have been borrowed by Tudors (Hulme 1909). However, the development of patent law in Britain continued. In 1623, in Britain the "Statute of Monopolies" was published, according to which patents were granted for projects of new inventions, by which property and copyright of the inventor in various fields were protected by a patent or charter (Орд-Хьюм 1980: 205–206; Mokyr 2002). It became the most famous document in the field of the emergent patent law. Since that time, Britain acted as a leader in this field, and the most significant events in the field of protection of the rights of inventors occurred in this country. For example, in 1711, in Britain for the first time it was required to provide a detailed description of the invention (Михайлов 2007). In other European countries, the patent law was introduced much later, but in the USA it was one of the first legal acts adopted in 1790.

Thus, we believe that the development of patent law in Britain was much more pronounced than in other European countries and that was one of the major reasons why it was Britain where the final phase of Industrial Revolution took place. From the history of the patent legislation it is clear that in Europe and in Britain in particular the urge toward innovations appeared several centuries before the completion of the industrial revolution, and it was so pronounced that it required the development of the legal protection of the inventors' rights. In turn, the emergence of a possibility to establish one's right over a certain invention created a positive feedback with the desire to innovate, making it a major driving force of development. The preparation of a patent application was not a simple matter, at the same time the patent was a guarantee that the investment in the invention can be recouped, and, therefore, there could be hope to find the funds (or investor) for bringing the invention to industrial use. Thus—due to the patent laws—capitals, hopes for higher profits and talents of inventors (who could potentially be rewarded not only by their monopolies, but also by entrepreneurs, or even government agencies) were connected. Yes, Clark is right that many of those who paved the way for the industrial revolution in Britain did not become rich people (Clark 2007: 234–238), but still most of them received at least something. So it is no accident that the history of the first decades of the industrial breakthrough is associated with the acquisition, purchase and sale of patents as well

[43] With the accession of the Tudor dynasty the patent system underwent a characteristic change. In place of the open letters for the furtherance of the national industry, we now find the Crown negotiating for the purpose of attracting skilled foreigners (for example, German armourers, Italian shipwrights and glass-makers, and French iron makers) (Hulme 1909). We also see that those monopolies were not without foreign precedents. Throughout Western Europe the new art of printing was being controlled and regulated by special licenses (Hulme 1909).

as litigation around them. That is why we do not agree with the opinion that the patent system itself played a minor role in the most innovative times of the British industrial revolution (Clark 2007: 238). It cannot be regarded as the main cause of this revolution (as the increase in the number of innovations was produced by a set of interrelated factors), but without the presence of the developed patent system, the industrial revolution could be significantly delayed.

Beginning and Apogee of the Great Divergence and the Emergence of the Capitalist World-System

Modernization of the West

Completion of the Industrial Revolution in Britain and Its Outcomes Roughly speaking, we can assume that the industrial revolution in England was completed by 1830.[44] What does this mean? In any case this statement should not be interpreted in such a way that by that time the main innovations had been already introduced. Quite the opposite. Completion of the Industrial Revolution means that by this time the industry, brought to life by the industrial revolution, had become a common thing, creating a primary model of industrial (machine-) production, which was spreading to new areas. In Britain one could find tens of thousands of machines and thousands of steam engines, steam was used in transport and the first railroad (1825) had been constructed. At the same time, by the early 1840s, the British economy was still actually a hybrid that organically included new and old forms of production. This can be seen in the fact that as late as in 1831, in Britain hand weavers were more than 80 %, and factory ones constituted less than 20 % [respectively 225 and 50 thousand (Цейтлин 1940)]. Completion of the Industrial Revolution was also marked by the first general cyclical economic crises in 1825 and 1837 (Мендельсон 1959, т. 1; Туган-Барановский 2008; Tugan-Baranovsky 1954; Гринин and Коротаев 2009в; Craig and Garcia-Iglesias 2010).

In Gellner's (1984) words, after the Industrial Revolution the production forces started feeling a great insatiable thirst for economic growth. Modern type of economic growth developed; according to Kuznets estimates, such a growth implies an increase in per capita average of not less than a per cent per year. Moreover, according to an important conclusion of Kuznets, this quantitative characteristic is achieved only when absolutely certain qualitative changes in the economy and in society's social and political structures are observed (Kuznets 1966). Thus, to ensure permanent growth, the British and European society was forced to change. And these changes were accompanied by intense social conflicts, which also became one of

[44] One of the important indicators for it is that in those years the number of steam engines in the British economy became equal to the number of the hydraulic engines—there were 160 thousand of each (Crafts 2004; Kanefsky 1979; Allen 2009).

the important driving forces in the development and Divergence. In general, it turned out that the movement to the modern trajectory of economic growth and the need to make changes in order to support this, formed a feedback loop, which ultimately strengthened the process of the Great Divergence.

Paradoxes of Economic Growth Now it is necessary to return to the question of how industrialization and modern industrial growth, on the one hand, correlate with rising living standards, on the other. Modern researchers have come to the conclusion that we are dealing with "the paradox of early growth", which means that economic growth, expressed as an increase in GDP per capita, only after a few decades leads to a marked increase in the wages of workers (Pamuk and van Zanden 2010: 219). Indeed, for quite a long time (at least about two to four decades), the growth of GDP and wages were in opposition. But in addition to the inequality in the distribution (Ibid.: 220f.), in our view, it is important to consider another aspect. The fact is that it is only possible to enter the modern economic growth through the accelerated accumulation and investment, which can be achieved only through the decrease in the share of consumption, including actual (absolute or more often relative) decline of earnings and the overall standard of living of certain segments (greater use of cheap labor of women and children is one of the forms of such a relative reduction (Ibid.: 218, 228–229). It is not surprising that industrialization often actually involved certain lowering in the population standard of living. And only a gradual increase in the wealth of society or the emergence of other sources of income could then lead to a real increase in living standards.

This gap between sustained economic growth and the rise of the standard of living is associated with the fact that the industrial revolution brought about the so-called demographic revolution (Armengaud 1976; Minghinton 1976: 85–89; Cipolla 1976: 15), or rather the first phase of the so-called demographic transition, characterized by a fall in mortality (particularly among children) while maintaining a high birth rate. As many studies have shown, up to the nineteenth century the humankind had been trapped in the Malthusian trap, whereby technical progress tended to lead to small rises in income per capita; however, population thus increased, but living standards remained the same (Artzrouni and Komlos 1985; Komlos and Artzrouni 1990; Steinmann et al. 1998; Kögel and Prskawetz 2001; Clark 2007; Goldstone 2007; Livi-Bacci 2012). The humankind (with some exceptions[45]) managed to escape this trap as a result of the global modernization, in general, and the Industrial Revolution, in particular (see, e.g., Korotayev et al. 2006b, 2011d; Grinin 2012b). This statement, however, needs substantial qualifications. Thus, we have come to the conclusion that in fact the escape (albeit slow) from the Malthusian trap started in such countries as the Netherlands and England back in the sixteenth century (see Гринин et al. 2009). On the other hand, even after the industrial revolution in many countries, the growth in the standard of living was hard and uneven, while for large segments of population it even deteriorated. The problem was not that the society

[45] See, e.g., Zinkina and Korotayev (2014).

was technically unable to provide an adequate standard of living, but that the society was still unable to smooth the resulting strong distortions in the allocation of resources; and in conditions of the increase of accumulation rates against the background of the absolute dominance of the private property in absence of a system of social insurance this inevitably led to the growth of inequality. We call this phenomenon a post-Malthusian or modernization trap (see, e.g., Grinin 2012b).

The increasing inequality was, incidentally, one of the major causes of the European revolutions and reform movements, which accelerated the development of countries and divergence, as they contributed to the formation of new societies based on the rule of law and tending toward the modern social state, which at that time was impossible in the East. Thus, the firm connection of the modern type of economic growth with rising standards of living needed not just only a rather significant period of time, it also needed a rather active social struggle both in violent (revolutions) and especially non-violent (reforms) ways (which greatly accelerated the search for sources of productivity growth and mechanization). It is not surprising that the nineteenth century in Europe was filled with such a strong political and class struggle.

Two Versions of the Final Phase of the Industrial Revolution The British version of the completion of the Industrial Revolution (which combined machines and *steam* energy) was not the only one. In those countries that had abundant water resources (in particular, the USA), hydraulic engines competed quite successfully with the steam engine until the 1860s. Efimov notes that "Machine and steam is the formula for the technological revolution in England. Machine and water wheel is the formula for the first phase of the machine stage of the American capitalism" (Ефимов 1955, see also Болховитинов 1983: 216; Allen 2009). In the United States the industrial revolution in the textile industry occurred almost exclusively on the basis of the use of water power. American industry (except railroads and steamers) lagged behind the British with respect to the use of steam engines. But it is quite natural if we recollect that North America has so many rivers whose energy was cheap and easy to use, and how much more expensive was the production and transportation of coal.

In general, even in 1860, water remained the main source of energy for American industry, and in the 1850s the advantages of steam and water engines were a subject of lively debate (Фостер 1955: 301).

But in the spheres where it was impossible to go without steam, practical Americans sometimes overtook the British even in the application of steam engines; and it is not really coincidental that the first steamboat was invented in North America by Fulton in 1807. Note, incidentally, that the first steamboats were fueled with cheap (for the USA) wood, thus, expensive (for the USA) coal was not required.

However, though the energy base of the early nineteenth-century North American industry might have looked primitive at first glance, the overall level of the North American technology was very high and in many respects superior to the British. In 1820, the United States had 250 thousand mechanical spinning spindles.

But the greatest progress was made in the following decade. In 1830, the number of mechanical spindles was equal to a million, in other words, it increased four times in 10 years (Цейтлин 1940: 237). American machines made such a sensation at an exhibition in Britain in 1851, that British experts were sent to the United States to study new American machines and to submit reports to the Government.[46]

Thus, "the Industrial Revolution is always essentially the same but the method in which it is accomplished varies according to the different historical conditions" (Cipolla 1976: 14).

At the beginning of the final phase of the Industrial Revolution (as is evidenced by the American version of industrialization), its main component should be identified with the introduction of machines replacing human labor, and the issue of energy could be settled to a certain point and in different ways. But, of course, the use of steam power is a more promising and versatile way, so it entrenched everywhere. Hence, steam engines gave to the new principle of production an energy framework and central element around which to create all the industrial system.

Diffusion of Industrialization: Modernization of the West Specific processes associated with industrialization, can be traced in Europe since the end of the eighteenth century, and by 1830, the growth of industrialization (although not as obvious as in Britain) was already visible in a number of countries. Then the modernization of European industry and transport proceeded rather swiftly. The objective of our study does not include a detailed analysis of the socioeconomic changes in Europe; at this point it appears sufficient to say that it was a profound revolution that transformed the continent with societies based on agriculture and with predominantly rural illiterate populations with high mortality and fertility into an urbanized industrial region densely covered by railroads, telegraph and telephone lines; as a result of this revolution Europe transformed from a society of peasants and landowners into a society of the industrial bourgeoisie and proletariat, into a society of literate citizens with low mortality rates (and, later, low birth rates) (see, for example, Broadberry and O'Rourke 2010). The scale of construction was impressive even by today's standards.[47] At the same time, these societies were moving towards democratization, equal rights and the gradual (though highly uneven and non-uniform) rise of living standards.

[46] The report quite adequately explained the exceptional success of the Americans in the production of machinery first of all by the acute shortage of workers in the country, the presence of a huge domestic market, high level of education and the widespread use of foreign experience (Болховитинов 1983: 215–216).

[47] It appears appropriate to mention here some quantitative data. The greatest scale of the railway construction in Europe was observed between 1850 and 1870. During that period, the European railway network grew from 14 thousand miles up to 65 thousand miles (Mosse 1974: 23). And in the decade between 1857 and 1866 the world's total railway increased by 75,000 km. Between 1860 and 1887, the telegraph network in Europe grew from 126,000 to 652,000 km and worldwide its length approached 1.5 million km, including 200,000 km of underwater lines (Мендельсон 1959, т. 2: 194).

The period from 1830 to the early 1890s is a period of complete victory of machine production and its powerful diffusion in the West. Whole sectors of light industry were transformed, but most importantly, heavy industry (coal mining, iron, steel, rolled metal production) experienced radical transformations, a separate industry emerged to produce machines for light and heavy engineering. The period witnessed a huge number of the most important inventions in all fields of manufacturing, communications, transport and energy—including the new ways of steel production: Bessemer, open-hearth; invention of the steam hammer by James Nasmyth (which gave a new impetus to the machine producing industries); the invention of a number of various rather accurate and convenient machine tools, electric telegraph, the use of electricity for lighting and other purposes, etc. (Musson and Robinson 1969; Hellemans and Bunch 1988; Davis 1998; Jonnes 2003). The huge growth of invention activities in this period is vividly demonstrated in Fig. 2.7 and Appendix A. To represent the amount of invention activities during this period it also appears appropriate to mention the following facts. Between 1851 and 1890, the United States issued about 470 thousand patents for inventions in various fields of science and technology (Kirkland 1961; Джинчарадзе 1973: 44–45). It was during that period the talent of Thomas Edison flourished (his brain was assessed in 1920 at $15 billion, counting his contribution to the development of the industry, in fact, this contribution was even more (Белькинд 1964: 7).

But the victory of the machine mode of production brought enormous changes in social and professional terms and meant depriving many millions of people of their usual activities, a quick growth of cities and a lot of acute problems associated with these.

By the end of this period, the balance of economic power in the West changed significantly. In general, by 1890, the balance in the world of industry looked as follows: Britain gave 18 % of the world pro-industrial production, the United States—31 %; Germany—16 %, France—7 % (Гинцберг 1960: 46). In the nineteenth century and early twentieth century, the European countries showed a rather rapid population growth, reaching the population of 468 million in 1913 (Armengaud 1976: 28; Maddison 2001, 2010; Livi-Bacci 2012). And a particularly rapid acceleration of population growth was observed in Western Europe (see. Fig. 2.8).

However, with respect to this (and perhaps, the only) indicator, Europe remained still very far behind the East (see Chap. 3 for details). But this was compensated by an unprecedented increase in the mechanical energy and power that was equivalent to manual labor of many hundreds of millions of people. In Britain, the total consumption of coal and wood in 1700 constituted only a twelfth part of the energy consumption of the same fuels in China. But by 1850, after a nearly twenty-fold increase in coal production, 18 million residents of Britain consumed 1.5 times more energy than 400 million Chinese (Smil 1994: 186–187; Goldstone 2009a: 164). Speaking about that period, R. Jones points that in Britain the steam engine performed the work of 600 million people, while the actual number of employees was 4 million (Джонс 1937: 351).

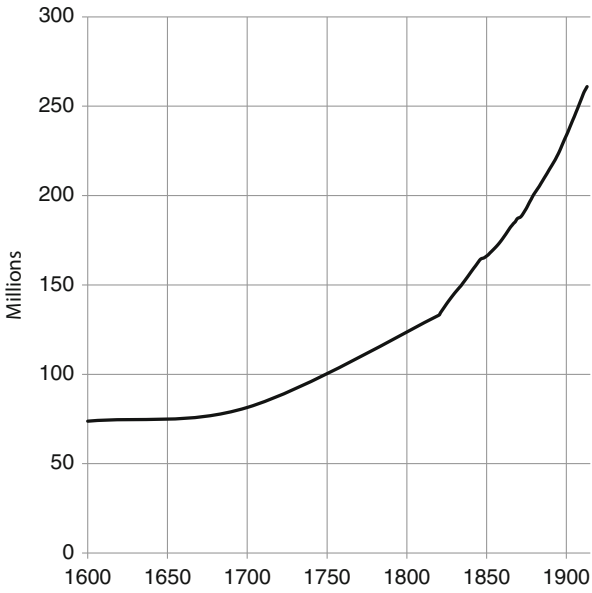


Fig. 2.8 Population growth in Western Europe, 1600–1913. *Data source*: Maddison (2010)

Subjugation of the East and the Start of Its Transformation

Globalization and Antiglobalization Now we return again to the preceding period. Representatives of the California school (Blaut 1993, 2000; Goody 1996, 2004; Wong 1997; Frank 1998; Lee and Wang 1999; Lieberman 1999, 2003; Pomeranz 2000, 2002; Goldstone 1991, 2000, 2002, 2009a, 2013; Hobson 2004; Rosenthal and Wong 2011; Vries 2013) are right when they point out that before the nineteenth century one cannot speak (especially with regard to the Far Eastern countries), that Europe played a crucial role in the affairs of the East, especially in economic terms (with the obvious exception of India and Java after their subjugation by the East India companies). Intra-Asian trade was of a larger scale than trade with Europe. The latter was more interested in this trade, but they could not offer much in exchange (except for American silver). They are right that Europe, firstly, fit into the existing trade relations (and did not create them), and secondly, that this trade generally had no great effect on Asia. However, the influence of Europe on Turkey, Iran and especially India and Indonesia gradually increased. However, with respect to the most developed countries of the Far East, the influence of Europe was reducing. To a very considerable extent this was caused by a rather effective policy of self-isolation, which the rulers of these countries started to pursue in the seventeenth century [partly due to the influence of Christian missionaries (Симоновская and Юрьев 1974; Gunn 2003; Laver 2011)]. Since those were centralized and rather strong states, European companies and countries did not have enough power to impose their will (and, of course, to conquer them). They were content with the possibility to trade, but trade was controlled by the East Asian governments and

conducted only in specific places. Thus, with respect to East Asia of that period, we can talk about anti-globalization, when communication with the outside world was limited and strictly controlled; respectively, the opportunities to learn from European innovations were minimal. According to Braudel's (1973) definition, China remained a world-system by itself, not particularly in need of any active external contacts.

For a very long time, antiglobalization was quite an effective policy, which the Far Eastern governments used to control their territory and isolate them from external influences (which generally, indeed, produced negative rather than positive influences on the East Asian societies). The seclusion policy was facilitated by the fact that foreign trade played a minor role in the economies of the Early Modern Far Eastern countries. For example, foreign trade in China in the eighteenth century, according to some estimates, accounted for only a per cent of its GDP (Непомнин and Меньшиков 1986: 55; Feuerwerker 1969: 2; Chang 1962: 291–317). Compare this with the fact that in 1720 the share of foreign trade in the overall GDP in France was 5.5 %; in Britain it was 19 %, while in the Netherlands it constituted 82 % (O'Rourke et al. 2010: 106). Fundamental differences in the structure of the economies of China and European societies are quite clear. However, objectively, this seclusion policy strongly contributed to the Great Divergence. While Britain (and the West in general) had been modernized, those Eastern countries that remained independent from the Europeans (with the exception of Turkey and Egypt) were basically following the same course, with the result that China and Japan, having exhausted the available resources, had reached the limits of demographic capacity of socio-ecological niche and that resulted in increasing social tensions. Not surprisingly, the encounter with the powerful West caused a deep crisis (which led, however, in China and Japan to qualitatively different results). Thus, the policy of the anti-globalization became, ultimately, one of the main causes of the deep crisis in the Far Eastern countries.

Forced Opening of China, Japan and Other Countries. Different Trajectories of Development of the East and Other Regions. Echoes of the Great Divergence

All relations between Europe and Asia between 1500 and 1900, can be generally expressed in two concepts: trade and colonial conquests, which often went hand in hand. The forced opening of China, which caused a deep crisis in the country, as is well known, started in trade (whereas the main subject of trade was the Indian opium). The Chinese government's attempts to stop this destructive trade led to the Opium War, as a result of which China had to open a number of ports for trade with the West. And then the country that was already on the edge of social and demographic crisis (e.g., Korotayev et al. 2006b), was shaken by the long and catastrophic Taiping Rebellion, during which, because of the lack of sufficient funding and control the Yellow River dams were broken and the river radically changed its course. All this led to disaster and according to some estimates, to the death of 118 million people (Cao 2001, 5: 455–689; Huang 2002: 528). Against this background, it is important to note that the gross domestic product of China's economy in the middle of the nineteenth century was still the largest in the world (see. Fig. 2.9).

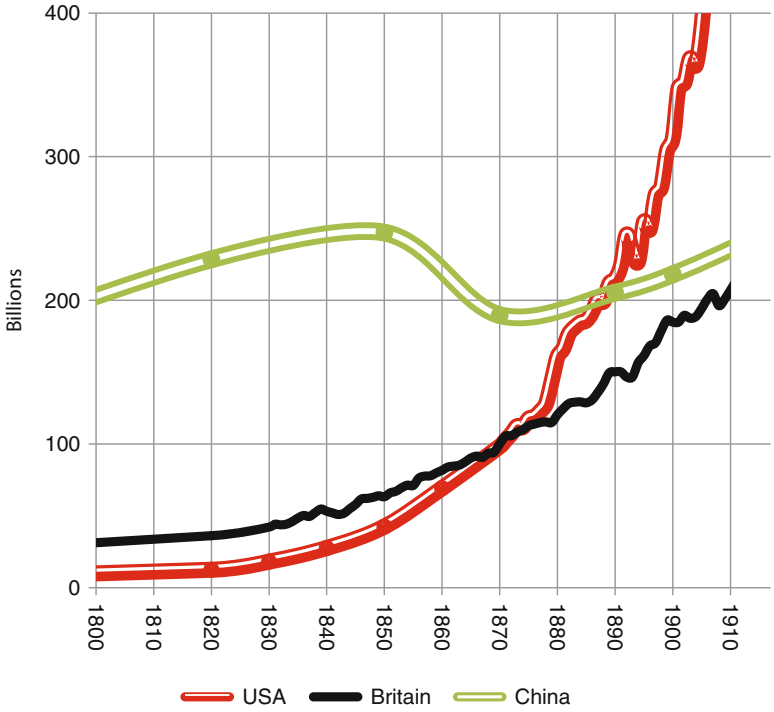


Fig. 2.9 GDP dynamics in the USA, Britain and China, 1800–1917, billions of international 1990 dollars, PPP. *Data source*: Maddison (2010)

Thus, the forced opening caused great damage to China. At first, China adopted a policy of self-empowerment and tried to modernize. Although China's first modernization ended rather unsuccessfully, nevertheless it changed the country rather considerably (Непомнин 2005; Liu and Smith 1980; Feuerwerker 1980; Chu and Liu 1994).

The opening of other countries (Vietnam, Siam) ultimately led to their transformation into colonies and semi-colonies. Colonial status, which was spread first to India and Indonesia, in the nineteenth century, became one of the main development paths for the East. For all its tragedy, nevertheless, it opened the way to a certain modernization of society (of course, difficult and flawed).

A rare case of successful modernization was Japan, which managed to make necessary reforms and create up-to-date army and navy. The reasons for this success are a subject of continuous discussions (see, e.g., Sanderson 1995, 1999),[48] but

[48] Among the reasons one could mention a larger willingness to learn from the West than was found among the Chinese, as the Japanese traditionally borrowed much more from abroad, as was noted by the Japanese researchers (Ōkuma Shigenobu) already at the beginning of the twentieth century (Загорский 1991: 68). Allen also points to a more creative use and adaptation of western technology to local conditions than in other modernizing countries in this period (Allen 2011).

somehow the example of Japan proved that it was not fatally impossible for the Asian countries to become a modern world power, to master European technology and implement the necessary institutions. The annual GDP growth in Japan after 1874 and prior to 1940 amounted to 5.5–5.8 % (Бабинцева 1982: 15), and in the beginning of the twentieth century they accelerated; the share of manufacturing also significantly increased (see, e.g., Allen 2011).

The development of Turkey and Egypt also demonstrated that the eastern countries could manage to fit the world economy and politics providing for right policies and required reforms. From the 1820s to the 1870s, Egypt managed to develop agriculture and to make use of the favorable situation with the raw material prices (especially, with respect to cotton prices). At the same time Egypt demonstrated a rather good performance, both in economic and military spheres (see Гринин 2006, 2007; Гринин and Коротаев 2009a, б for our analysis of the development of Egypt).

From 1860 to 1870, 13,000 km of irrigation channels were constructed (Белоусова 2004: 143). From 1843 to 1872, there was a five-time increase in the foreign trade volume (Смилянская and Родионов 2004: 372). One could observe an active construction of railways and telegraph lines, modernization of ports, etc. In 1869, the construction of the globally important Suez Canal was finished. However, the errors of the Khedive Ismail, who went into debt in connection with the construction of the Suez Canal (in view of persisting high prices for cotton), as well as the growth of local nationalism led to the crisis, whereas Britain took advantage of it to occupy Egypt (on the occupation of Egypt and the penetration into China see, e.g., Owen 1969; Flower 1972; Tignor 1966; al-Sayyid Marsot 2004; Зеленев 2003; Гринин 2006, 2007; Wright 2001). Nevertheless, in many respects, the British protectorate contributed to the development of Egypt, especially its agriculture (as Britain needed its cotton and some other raw materials). Turkey during the nineteenth century undertook more or less successful attempts at modernization, which ultimately saved it from a complete partition between stronger players. However, it failed to rise up to the level of the European powers. But even those attempts at modernization that were not entirely successful still contributed to it in a rather significant way.

Formation of the Capitalist World System with Europe in Its Center The Great Divergence meant a powerful development of economic globalization and resulted in the formation of the capitalist World System with its center in Europe. Globalization involved eastern countries (as Latin America before that) in the world market, and by the late nineteenth century, the final partition of colonies among Western powers took place. Among other things the Great Divergence meant a geographic expansion of the West, it also meant a certain catch-up of the European periphery and the West European offshoots (the United States, Canada, Australia, and New Zealand). The involvement of these regions into the orbit of British economy (and of the European economy in general), including the discovery of gold in California and Australia, was extremely important. One can hardly overestimate the role of the exports of British goods and capitals to the United States, as well as migration there (as well as to other colonies) of many millions of Europeans.

Trade and Economic Relations Between the West and the East in the Period of the Great Divergence. Contradictory Results of the Involvement of Non-European Countries in Global Processes The clash with Europe, with its industrial and military power, in different countries proceeded in different ways, but somehow it tended to cause various socio-political and economic crises (endless revolutions and coups in Latin America, the revolt in India in 1857 and in Indonesia in the 1840s, Taiping Rebellion in China, the Meiji Restoration in Japan, the revolt of Arabi Pasha in Egypt in 1881–1882), and in some cases attempts to modernize. Crises often added momentum to the process of transformation of the Eastern states, without which modernization would be impossible.

In principle, the Great Divergence could not develop without the process of globalization, as from the outset of industrialization the new machine industry, on the one hand, needed an expanding supply of raw materials and later food, which could not be achieved without active involvement of more and more countries in the procurement process and, on the other hand, without development of exports and constant expansion of markets. Both colonial and formally independent countries became buyers of manufactured goods, suppliers of raw materials and food, thereby engaging the global division of labor. The inclusion of the periphery as a source of raw materials and consumer of finished goods meant, on the one hand, the consolidated division of roles in the global system, and hence the consolidation of the Divergence results or even the movement of Divergence to a higher level. But on the other hand, this prepared conditions for the onset of Convergence, since the inclusion of the periphery in the world of technology and world market meant the increase in its general level of development, the growth of infrastructure and exports of capitals.

In order to expand their markets, Britain and other European countries did everything starting from large credits to potential buyers to launching unjust wars. It is not surprising that such progress was often very difficult and tragic. In general, in 1830–1870, in many non-European peripheral countries vigorous imports of manufactured goods from Europe, alongside with the absence of sovereignty or in the presence of non-equivalent trade agreements, resulted in a significant reduction of local manufacturing, of the number of artisans and even urban population in general (Мельянцев 1996: 126 and 127). Many artisans were forced to move to villages (see Allen 2011). These processes (as well as severe socio-economic and political crises in many countries of the East) brought even certain temporary lowering of the standard of living in some regions. Thus, according to some estimates, from the late eighteenth century to the last third of the nineteenth century in the countries which in the twentieth century would constitute the Third World, an average income reduced by 10–15 % (Мельянцев 1996: 129; Bairoch 1992: 446). However, according to Maddison's calculations (2001, 2010) in most countries of Asia, Africa and Latin America, this indicator still grew but not as significantly as in the countries of the World System core. The consequences were particularly hard for India. Between 1830 and the 1850s, the British cloth exports to India increased by 60 (!) times (Бобровников 2004: 423). This resulted in massive bankruptcies of

artisans. The population of Dhaka, the major industrial center of Bengal, for example, fell from 150 to 30 thousand people (Бобровников 2004: 423).

The Chinese market, as we have said, was partially opened as a result of the First Opium War and the Treaty of Nanking in 1842 (see, e.g., Pomeranz 2000; Нарочницкий 1973; Непомнин 2005). At first it seemed immense to the British entrepreneurs. British manufacturers seriously put their minds to "dress 300 million people". As a result, after 1842, one could observe such a vigorous boom in the establishment and modernization of factories that complaints about difficulty to find workers and to survive wage increases became permanent (see, e.g., Туган-Барановский 2008 [1894]: 122). But sales to China turned much lower than expected. However, between 1842 and 1845, total exports to India and China increased by a third (Трахтенберг 1963: 150).

With formally sovereign countries, Britain and other countries (including Russia) concluded unequal trade agreements, which resulted in active penetration of European goods to their markets (as well as an active penetration of European financial structures in their financial systems) (see, e.g., Cuno 1985; Issawi 1947; Owen 1969; Hunter 1999; Goldschmidt 2004 with respect to Turkey and Egypt). It tuned these countries' economies to the needs of Britain and other European countries, but that also led to their significant development—including the development of advanced infrastructure and forms of monetary and trade relations (which can be particularly well illustrated by the examples of Canada or Australia). The dependent countries become raw-materials suppliers. In particular, those were India, Egypt, Indonesia, Brazil, Argentina and other countries of Latin America [but also such prosperous countries as Canada, Australia, and New Zealand (and even the USA for a long time)].[49]

And moreover, the need for broadening and deepening of globalization began to be perceived when the need to export capital developed. And such exports from Britain to some countries (first of all, of course, to India) began in the 1850s. This was facilitated by the elimination of the East India Company (after the 1857 Sepoy Mutiny) and the establishment of the direct British control over India. The British capitals went to India in much larger quantities together with technologies and experts, local cotton factory industry started to develop, and so on (see on the economic development of India, e.g., Nehru 1982; on quite serious difficulties of this development see Clark 2007: 346–369).

In the late 1850s and the 1860s, Britain built 5,000 km of railways in India (Мендельсон 1959, т. 1: 610). In general, the construction of the Indian Railways was a crucial part of British investments in Indian infrastructure, and the quality

[49] Why did the flow of European capitals and technologies to Canada or Australia lead to their successful modernization, and why did not it produce the same result in Brazil or India? In the nineteenth century, Canada, Australia, India, and Brazil were turned into an agrarian and raw material appendages of Western Europe and the United States. This, however, did not prevent Canada and Australia to join the club of developed countries, while Brazil and India as a result of the processes of the Great Divergence found themselves among the Third World countries. What is the explanation? We will try to answer this question below in Appendix B to this book.

of construction and equipment was even higher than in the United States (see Clark 2007).

The export of capital became, in our opinion, the most important source of change in the balance in the development of the World System core and periphery. However, it took many decades before it produced any tangible results.

One can argue to which extent the rise of the West was fertilized by its exploitation of the colonies and semi-colonies and unequal exchange with them, but clearly the process of involving semi-periphery and periphery in the world's economic and political relations was inseparable from the process of the Great Divergence and rise of the West. But at the same time it was the process that also launched the reverse process, which about half a century later became a matter of global dimension, the results of which became apparent in a 100 years, and now it is visible as the Great Convergence. For without the involvement of the peripheral countries into the orbit of economic relations on the basis of the latest techniques and technologies (even although these countries had been given a purely raw-exports role and were objects of predatory exploitation) there were no real opportunities for their new rise in the Modern world.

In Chap. 4 we will analyze in more detail the processes that gradually prepared the prerequisites for the onset of the Great Convergence.

Chapter 3
Great Convergence and the Rise of the Rest

In the 1980s, 1990s, and even 2000s, many economists failed to detect behind formal indicators the profound changes in the Third World that prepared fundamental changes and the onset of the Great Convergence. Even at that time the absolute majority of Western economists seem to have been in unanimous agreement over the absence of absolute convergence across the world (see, e.g., Sadik 2008; Epstein et al. 2007; Seshanna and Decornez 2003; Workie 2003; Canova and Marcet 1995; Durlauf and Johnson 1995; Desdoigts 1994; Paap and van Dijk 1994). Thus, Sachs et al. noted in 1995 that in 1970–1995 there had been no overall tendency for the poorer countries to catch up, or converge, with the richer countries.

In 1996 Sala-i-Martin, having analyzed a large cross-section of 110 countries, stated that one of the main lessons to learn from the classical approach to convergence analysis is that "the cross-country distribution of world GDP between 1960 and 1990 did not shrink, and poor countries have not grown faster than rich ones. Using the classical terminology, in our world there is no σ-convergence and there is no absolute β-convergence" (Sala-i-Martin 1996: 1034).

Much attention was given to empirical testing of the convergence hypothesis in Quah's works (see, e.g., 1996a, b, c). Using the model of growth and imperfect capital mobility across multiple economies to characterize the dynamics of (cross-country) income distributions, Quah tested the convergence hypothesis and came to conclusion that the evidence showed little unconditional cross-country convergence.

This idea corresponds quite well to the one expressed by Lee et al. (1997) that world countries are not converging, but diverging, which they resumed from considering international per capita output and its growth using a panel of data for 102 countries between 1960 and 1989. Much the same conclusion was almost simultaneously made by Bianchi (1997) who empirically tested the convergence hypothesis from the perspective of income distributions in a cross-section of 119 countries. By means of statistical techniques such as non-parametric density estimation and bootstrap multimodality tests, Bianchi tested for the number of modes and estimated,

L. Grinin, A. Korotayev, *Great Divergence and Great Convergence*,
International Perspectives on Social Policy, Administration, and Practice,
DOI 10.1007/978-3-319-17780-9_3

consistently with the detected number of modes, the income distribution of a cross-section of 119 countries in 1970, 1980 and 1989, concluding that his findings support the view of clustering and stratification of growth patterns over time, standing in sharp contrast with the unconditional convergence prediction.

One of the most recent works refuting the unconditional convergence hypothesis is the one by Acemoglu (2009), which contains a cross-country analysis of GDP per capita values between 1960 and 2000; what is more, he maintains that "there is a slight but noticeable increase in inequality across nations" (Ibid.: 6).

The conclusion on the continuation of divergence was shared by many researchers, for example, Gaulier et al. (1999), who based their research upon empirical evidence obtained from the analysis of 86 countries. A more recent work by Howitt and Mayer-Foulkes (2004) similarly resumed that among the countries of the world the divergence, not convergence could be observed starting from the early nineteenth century (see also Clark 2007; Allen 2011).

Numerous students shared the point of view on the absence of absolute convergence throughout the countries of the world (see, e.g., Sadik 2008; Epstein et al. 2007; Seshanna and Decornez 2003; Workie 2003; Canova and Marcet 1995; Durlauf and Johnson 1995; Desdoigts 1994; Paap and van Dijk 1994).

In the meantime, as one can see from the figures in this chapter, the symptoms of the movement from the Great Divergence trend toward the Great Convergence one became rather well visible already in the 1960s and 1970s.

Below we will demonstrate how much the Great Convergence process has advanced by now notwithstanding all those conclusions and predictions, whereas the explanation of the Great Convergence factors will be given in Chap. 4.

Long-Term Divergence–Convergence Trends as Regards the GDP

According to Maddison's (2001, 2010) data the share of the West in the world GDP (at PPP) grew quite noticeably in 1000–1800 (which correlates quite well with various "small divergence" theories); however, the explosive growth of this share started after 1800 (which, in its turn, correlates very well with the California School's Great Divergence theory). By the end of the nineteenth century, the share of the West in the world GDP exceeded 50 %, whereas in the 1950s and 1960s it was more than 60 %. However, according to Maddison, since the late 1960s this share started to decrease with an accelerating speed (see Fig. 3.1).

It is difficult not to notice that the shape of this curve resembles rather strikingly the shape of the curve of the world population relative growth rates' dynamics (see Fig. 3.2).

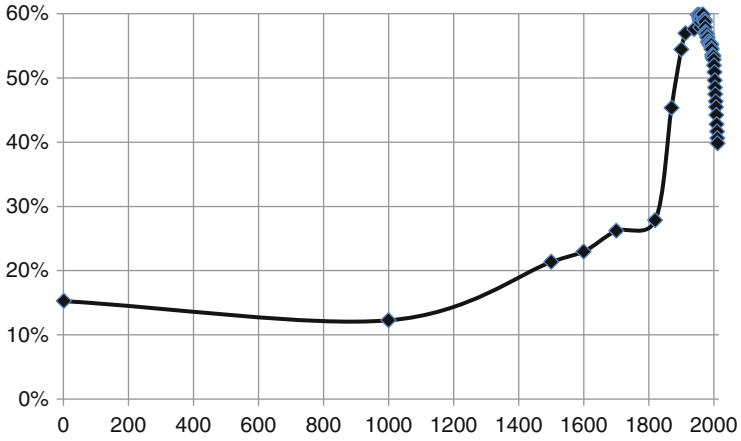


Fig. 3.1 Dynamics of the share of the West (In this chapter we denote as "the West" the following group of countries (roughly corresponding to the high-income OECD countries at the onset of the explicit Great Convergence in the late 1980s): all the countries of Western Europe, the USA, Australia, New Zealand, Canada, and Japan.) in the world GDP. *Data sources*: till 2008—Maddison (2010); after 2008—World Bank (2014): NY.GDP.MKTP.PP.KD. To secure the compatibility of two series, the World Bank GDP data have been re-calculated with Maddison's coefficients of the conversion of nominal US dollars into international dollars at purchasing power parity (PPP)

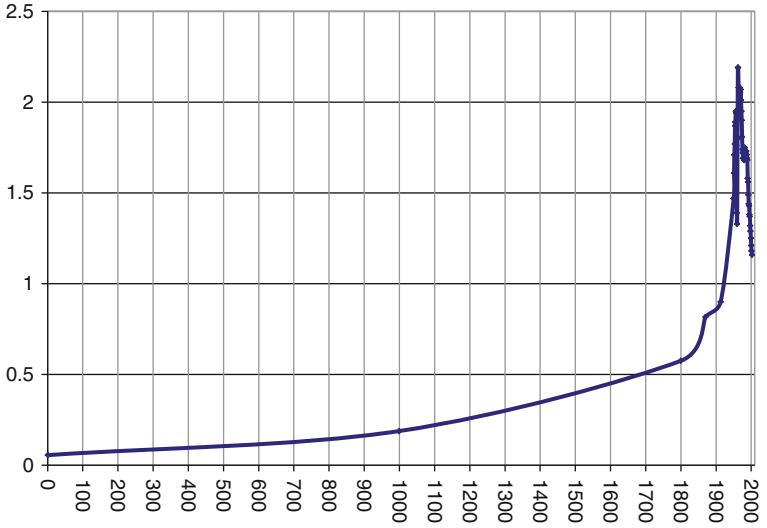


Fig. 3.2 World population relative growth rates' dynamics, 1–2003 (%). *Source*: Коротаев et al. (2007: 12). Before 1800 the curve represents a trend line that does not take into account cyclical and stochastic fluctuations

We believe this is not a mere coincidence. Actually, some time ago we already made the following observation:

> "One could hardly fail to notice that the turnaround of the secular trend toward the growth of the gap between the World System Center and the World System Periphery[1] to the trend toward the decrease of this gap coincided with an amazing accuracy (almost about a year) with the turnaround of a number of other secular (and sometimes even millennial) trends to the opposite ones. We should note the transition from millennial trends to the increase in global relative growth rates of population and GDP (as well as GDP per capita) to contrary trends to the decrease of those rates. One may also note a turnaround of the millennial trend toward the decrease of the effectiveness of the energy consumption to the opposite one (i.e., to the growth of this effectiveness). There are certain grounds to maintain that this synchronicity is not coincidental, as it reflects the point that we are dealing here with different aspects of the single process of the World System development, with different aspects of the single process of the World System's withdrawal from the blow-up regime and the start of its movement toward the trajectory of sustainable development. Indeed, all those new trends that emerged in the 1970s and the 1980s (the ones toward the slowdown of the relative growth rates of world population and GDP, toward the growth of energy consumption effectiveness and the decrease of the economic gap between the Center and the Periphery) have a certain 'common denominator'—all of them lead to a certain stabilization of the World System development and to a certain discharge of the strains that have accumulated within it" (Коротаев et al. 2010: 68–69).

This important point will be considered in more detail in Appendix B to the present monograph.

Consider now in more detail the dynamics of the share of the GDP of the West and the Rest after 1800 (Fig. 3.3).

This diagram suggests that, according to Maddison, the West's share in the world GDP started to contract since the late 1960s. However, until the late 1990s this contraction proceeded at a rather slow rate; the West's share in the world started to decrease (and—respectively—the share of the Rest started to increase) at a really fast pace after 2000.

In Fig. 3.4 one can see in an especially clear way the point that for quite a long time the West's GDP has been growing slower than the total GDP of the Rest.

As we see, between 1968 and 2012 the total GDP of the Rest grew by seven times,[2] whereas the West's GDP only tripled within the same period of time. However, this was only after 2000 when the GDP growth rates of the Rest started to exceed the Western growth rates in a really radical way[3] (see Fig. 3.5).

As we see, after 2000 the total GDP of the West has only grown by 20 %, whereas the GDP of the Rest has doubled, that is, it has grown by 100 %—thus, as regards

[1] As we will see below in Appendix B, the long-term curve of the gap between the First and Third World as regards per capita GDP resembles the curve of the world population growth rate dynamics even more.

[2] It appears necessary to stress that we will obtain such results only when we apply Maddison's coefficients for the GDP conversion at purchasing power parity. As we will see below, when using other coefficients we tend to get significantly different results (especially, as regards the period between 1968 and 1998).

[3] And—as we will see below—we will get a similar result in this case even if use any other GDP conversion coefficients.

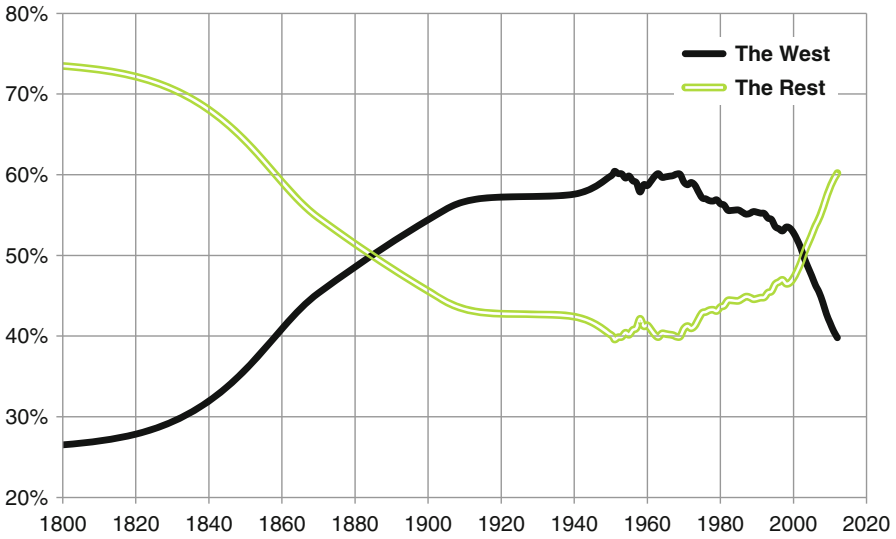


Fig. 3.3 Dynamics of the share of the West in the world GDP after 1800 (according to Maddison). *Data sources*: till 2008 (including 2008)—Maddison (2010); after 2008—World Bank (2014): NY.GDP.MKTP.PP.KD. In order to secure the compatibility of data for the period after 2008, the World Bank GDP data have been recalculated in accordance with Maddison's coefficients of conversion of nominal US dollars into international dollars at purchasing power parity (PPP)

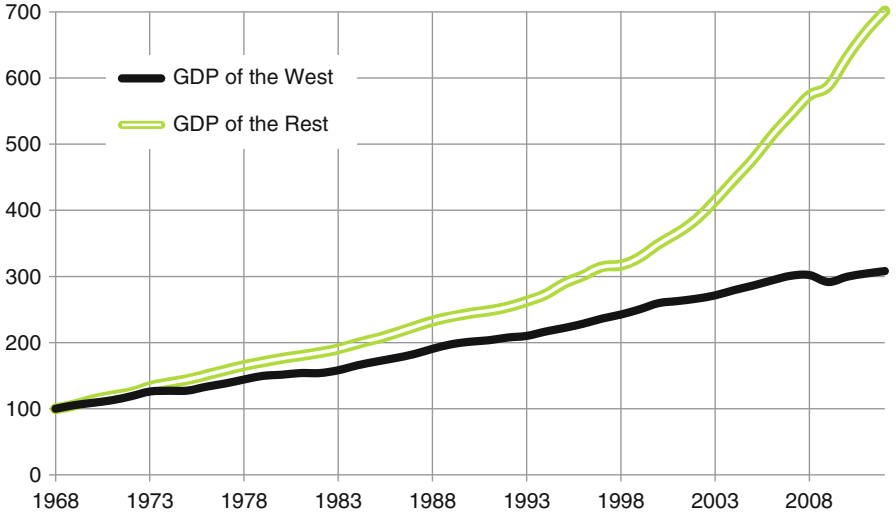


Fig. 3.4 Relative dynamics of the GDP of the West and the rest of the world (according to Maddison), 1968–2012, 100 = the 1968 level

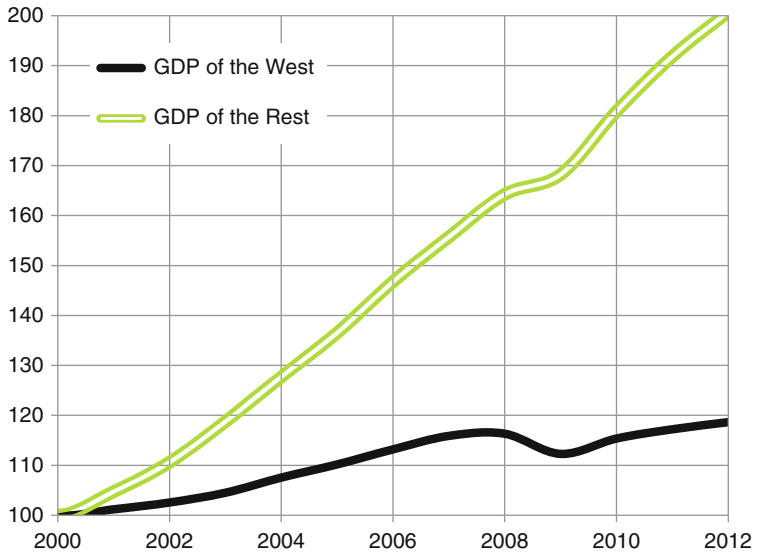


Fig. 3.5 Relative dynamics of the GDP of the West and the rest of the world (according to Maddison), 2000–2012, 100 = the 2000 level

average annual economic growth rates, the Rest has been developing five (!) times as fast as the West.

In the meantime, it appears essential to take into account the point that here much depends on the unit of measurement we use—that is, on the type of dollars with which we measure the GDP (and which GDP conversion coefficients at PPP we use). Indeed, as soon as we start using World Bank coefficients, the resultant picture changes in a rather significant way (see Fig. 3.6).

As we see, when we use World Bank GDP conversion coefficients, we get the impression that, as regards the variable in question, the convergence of the West and the Rest only started after 1994; it proceeded very slowly until 1999, but it accelerated immensely between 1999 and 2012, whereas after 2002 it proceeded at a really fast pace—as a result of which already in 2012 the share of the Rest in the world GDP exceeded the West's share (while just 15 years ago the share of West exceeded the share of the Rest almost twice).

Note that after 2000, the World Bank data on the relative GDP growth rates in the West and the Rest (calculated in constant 2005 international dollars converted at PPP using the World Bank conversion coefficients) portray a picture (see Fig. 3.7) that is very similar to the one that we arrived at above when using Maddison's estimates.

On the one hand, the almost complete identity of the curves for 2008–2012 is not surprising here at all, as above we extended Maddison's time series to those years on the basis of the World Bank data; however, on the other hand, it is much more

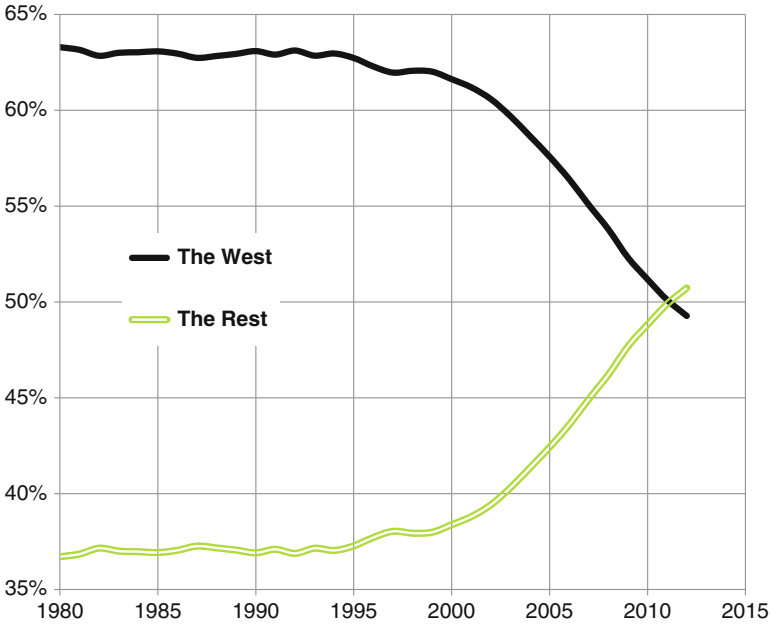


Fig. 3.6 Dynamics of the share of the West and the rest of the world ("the Rest") in the global GDP after 1980 (based on the World Bank data on the GDP calculated in 2005 purchasing power parity international dollars). *Data source*: World Bank (2014): NY.GDP.MKTP.PP.KD

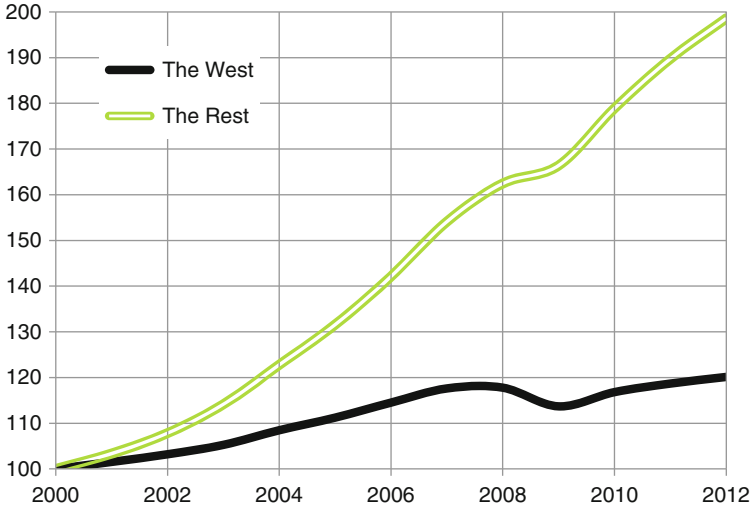


Fig. 3.7 Relative dynamics of the GDP of the West and the rest of the world (based on the World Bank data on the GDP calculated in 2005 purchasing power parity international dollars), 2000–2012, 100 = the 2000 level

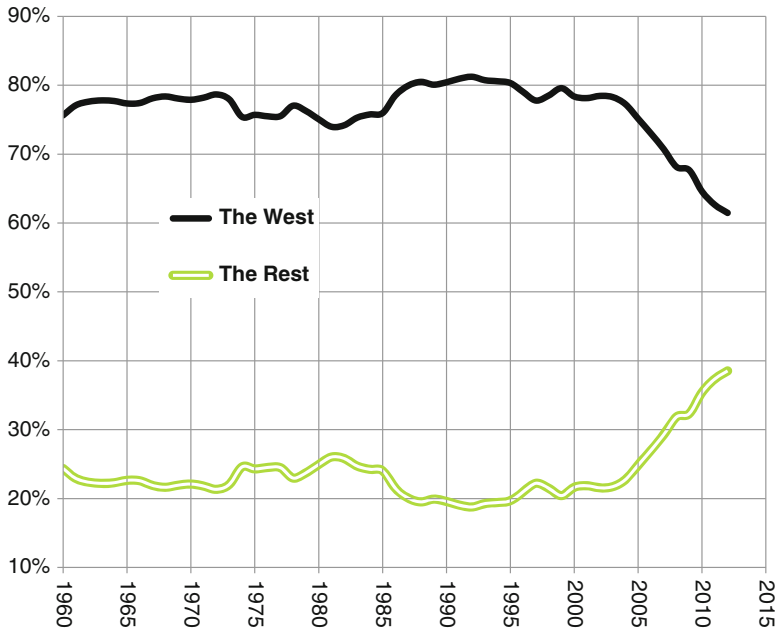


Fig. 3.8 Dynamics of the share of the West and the rest of the world ("the Rest") in the global GDP after 1980 (based on the World Bank data on the GDP converted into current US dollars according to current market exchange rates). *Data source*: World Bank (2014): NY.GDP.MKTP.CD

remarkable that both Maddison's estimates and World Bank data portray an extremely similar pattern for the period between 2000 and 2008.

Note that the results of such a comparison will be somehow different if we calculate GDP not in power purchasing parity international dollars, but rather in US dollars (whereas the GDP of particular countries is calculated by the conversion of their GDP in local currency into US dollars according to market exchange rates). Indeed, in this case we get a rather different picture (see Fig. 3.8).

As we see, in this case the initial gap between the West and the Rest appears to be much larger. What is more, the convergence in the 1990s and the early 2000s looks much less pronounced, whereas a really fast convergence only starts after 2003. However, for recent years both systems of measurement demonstrate a rather similar pattern of an extremely fast convergence, with the GDP growth rates of the World System core countries lagging very far behind the countries of the periphery[4] (see Fig. 3.9).

Thus, though different data series portray rather different patterns of convergence between the West and the Rest as regards their shares in the world GDP, they

[4] Note that here we quite consciously apply a simplified dual World System structuration scheme that only singles out the World System core and periphery and ignores the subdivision of the latter into the periphery per se and semiperiphery.

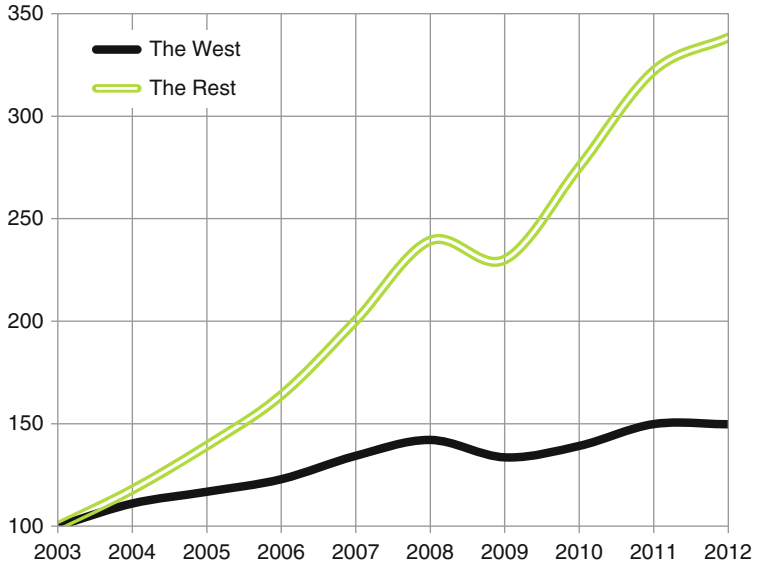


Fig. 3.9 Relative dynamics of the GDP of the West and the rest of the world (based on the World Bank data on the GDP converted into current US dollars according to current market exchange rates), 2003–2012, 100 = the 2003 level

are very congruent regarding the point that in recent years the convergence has been going on at extremely fast rates indeed.

Note, that an astonishingly similar picture of the world convergence pattern was detected by William Thompson when he tried to trace long-term dynamics of the Western share in the world manufacturing (see Fig. 3.10).

As we see, according to Thompson's calculations a really fast convergence between the West (≈ the World System core) and the Rest (≈ the World System periphery) only started (as regards the very important variable in question) after 2000; however, afterwards it proceeded at precipitously high rates—thus, between 2005 and 2010 (just in 5 years!) the gap between the West and the Rest decreased by one half. With such an extremely high convergence rate the Rest may catch up the West (as regards its share in the world manufacturing) already by 2015–2020.[5]

On the Dynamics of the West's Share in the World Population

For a more profound understanding of the issue of the Great Divergence and Great Convergence, it appears necessary to take into account the dynamics of the West's share in the overall population of the world (see Figs. 3.11 and 3.12).

[5] However, this may happen a few years later (for reasons see *Statistical addendum to this chapter*).

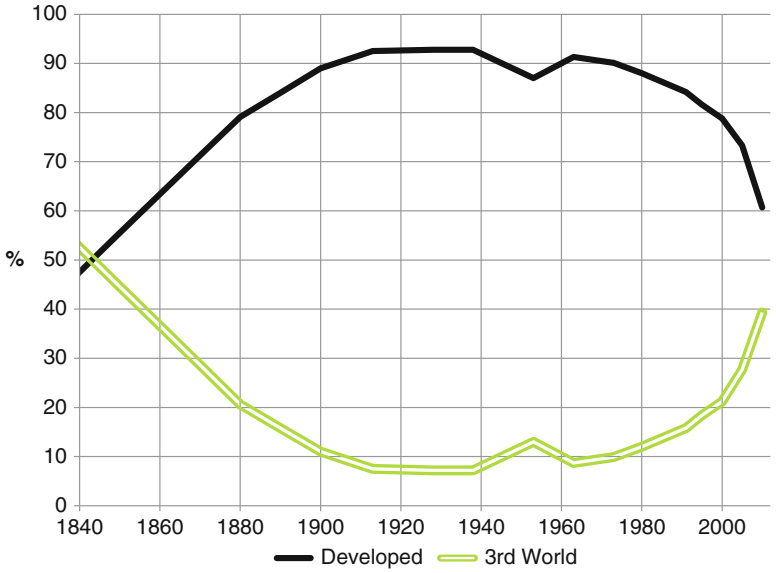


Fig. 3.10 Long-term dynamics of the Western share in the world manufacturing, %, 1840–2010. *Source*: Thompson (2014)

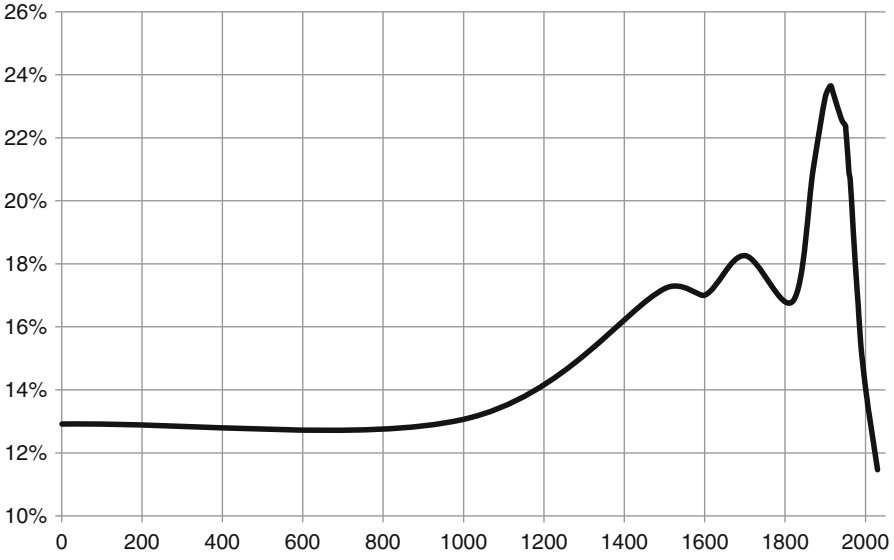


Fig. 3.11 Share of the West in the total population of the World, 1–2009 with a forecast till 2030 CE. *Data source*: Maddison (2010)

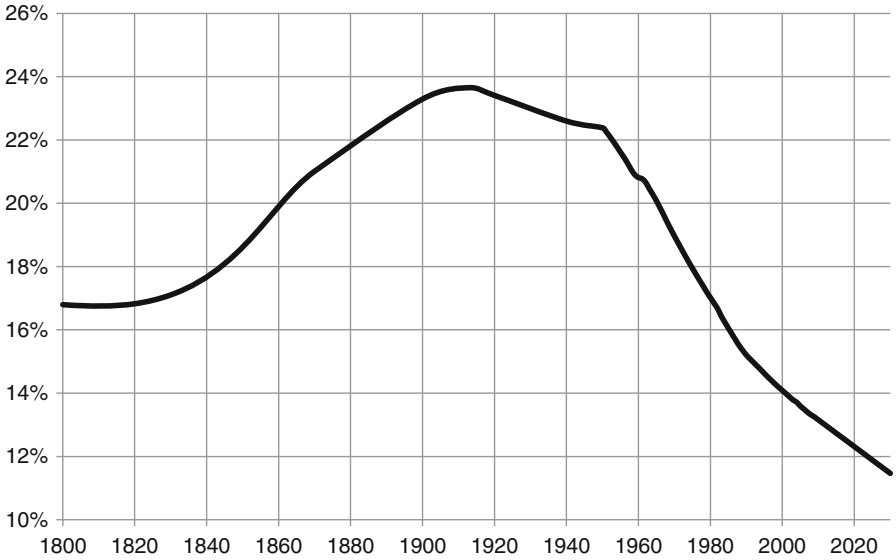


Fig. 3.12 Share of the West in the total population of the World, 1800–2009 with a forecast till 2030 CE. *Data source*: Maddison (2010)

As we see, the point that an especially fast divergence between the West and the Rest (as regards their shares in the world GDP) was observed in the nineteenth century had a rather strong demographic component. In that century, the explosive growth of the share of the West was accounted both by a very fast (at least in the millennial perspective) increase in the productivity of labor (and, thus, the GDP per capita) caused by the economic modernization,[6] and by a rather fast growth of the share of the population of the West in the total population of the world caused by the demographic modernization. Indeed, this was connected with the point that in the nineteenth century the population of the West grew much faster than the population of the Rest. This fact was not coincidental either—actually, in the West, the acceleration of the growth of the labor productivity and the acceleration of the population growth were two aspects of the single modernization process. In the nineteenth-century West, one of the main consequences of the start of an intensive economic modernization was the start of its demographic modernization—that is, the start of the demographic transition (Вишневский 1976, 2005; Chesnais 1992; Caldwell et al. 2006; Dyson 2010; Livi-Bacci 2012). As is well known, the first phase of the demographic transition (which the West passed precisely in the nineteenth century) is characterized by a radical decrease of mortality (Вишневский 1976, 2005; Chesnais 1992; Caldwell et al. 2006; Gould 2009; Dyson 2010; Reher 2011;

[6] In the same time the Rest lagged far behind the West as regards its economic modernization (and—hence—as regards the labor productivity growth).

Livi-Bacci 2012). A comparable decrease of fertility is only observed at its second phase (which the West entered only in the very end of the nineteenth century and the early twentieth century). Respectively, throughout the whole nineteenth century the very fast decline of mortality took place in the West against the background of still very high fertility levels, that led to an explosive increase in the natural population growth rates (due to the lagging modernization, in most countries of the Rest a comparable acceleration of the demographic growth only took place in the second half of the twentieth century). Thus, it is not coincidental at all that in the nineteenth-century West, the higher (than in the Rest) GDP per capita growth rates were accompanied by the higher (than in the Rest) population growth rates, which led to an especially fast growth of the West's GDP share in the world GDP.

On the other hand, in the twentieth century, the West entered the second phase of the demographic transition, the fertility started to decrease there more and more—hence, the demographic growth rates decelerated in a very significant way (in some countries even to negative values). In the meantime, in the twentieth century the majority of the countries of the Rest entered the first phase of the demographic transition, which meant a very significant decline of mortality against the background of still very high fertility. As a result, already by the beginning of World War I the share of the West in the world population had reached its peak, whereas afterwards it began to decrease, but till the 1950s this decrease proceeded very slowly. However, in the 1950s, when most countries of the Third World entered the first phase of the demographic transition, these countries experienced a demographic explosion, which, additionally, took place against the post-Baby Boom fertility decrease in the First World—as a result in the 1950s, 1960s, and 1970s the share of the West in the total population of the Earth was decreasing very fast indeed. The rate of this decrease only started to slow down after the late 1980s as a result of the entering the second phase of the demographic transition by the majority of the Third World countries (see, e.g., Caldwell et al. 2006; Gould 2009; Dyson 2010; Reher 2011).

On the Dynamics of the Gap Between the West and the Rest as Regards the Per Capita GDP

All the above-said should be taken into account when we consider the dynamics of the gap between the West and the Rest as regards the GDP per capita (see Figs. 3.13, 3.14, and 3.15).

Note that Figs. 3.13, 3.14, and 3.15 above may suggest that the convergence between the First and Third World only really started in the 2000s. However, this impression is not quite correct. The fact is that at this point we should take into account the fact that the Rest is not equal to the Third World, as in addition to the Third World it includes the Second World (that is the former "Communist Block"—the countries of the former USSR as well as the former Communist countries of the East Europe). Thus, it appears necessary to consider separately the long-term economic development of the Second World countries (see Figs. 3.16, 3.17, and 3.18).

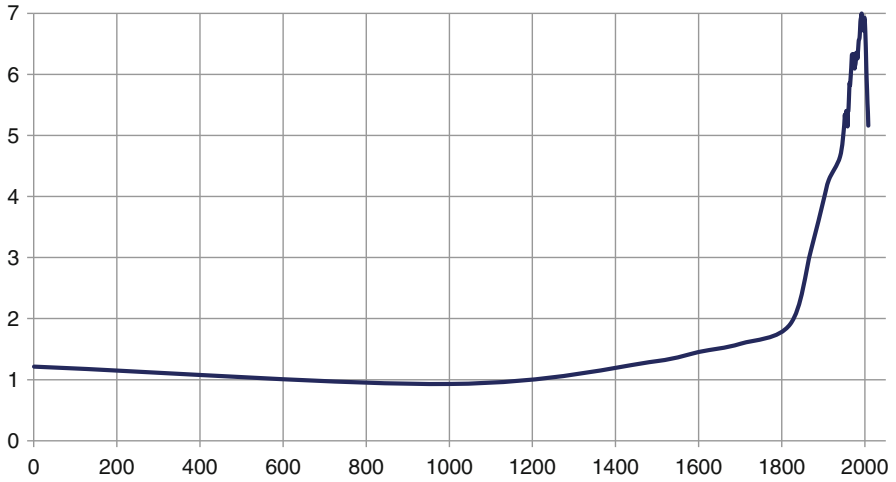


Fig. 3.13 The dynamics of the gap in GDP per capita (by how many times) between the West and the Rest, *1–2008*

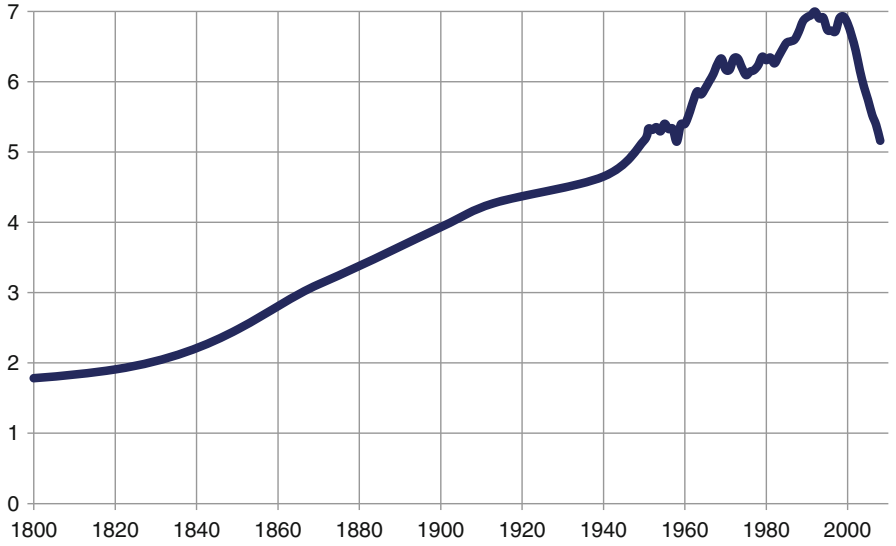


Fig. 3.14 The dynamics of the gap in GDP per capita (by how many times) between the West and the Rest, *1800–2008*

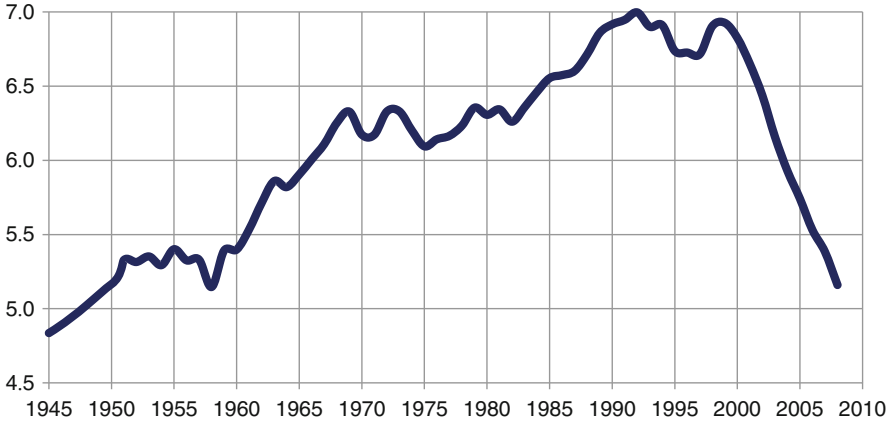


Fig. 3.15 The dynamics of the gap in GDP per capita (by how many times) between the West and the Rest, *1945–2008. Source*: Maddison (2010). Note that Maddison provides GDP estimates in 1990 Geary–Khamis international dollars at purchasing power parity

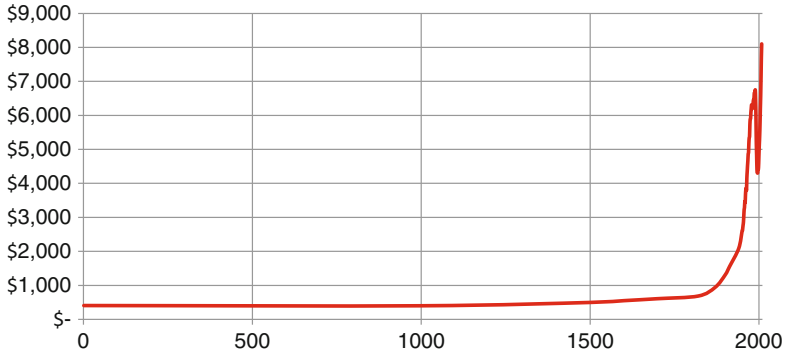


Fig. 3.16 The Second World per capita GDP Dynamics, *1–2008. Data* source: Maddison (2001, 2010). Note that Maddison provides GDP estimates in 1990 Geary–Khamis international dollars at purchasing power parity

As we can notice, in the Second World the economic crisis of the 1990s was unusually deep and long with an average decline of the per capita GDP by more than a third (that is it was significantly stronger than the Great Depression in the USA), whereas on average it took the Second World 16 years to return the per capita output to the pre-crisis level (for comparison in the 1930s, the same task took the USA 11 years).

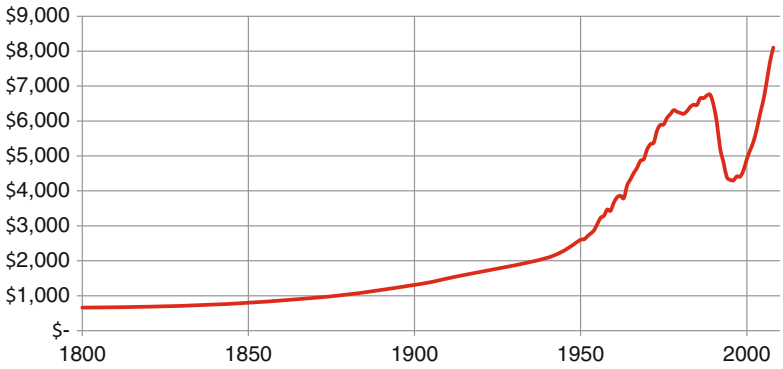


Fig. 3.17 The Second World per capita GDP Dynamics, *1800–2008. Data source*: Maddison (2001, 2010). Note that Maddison provides GDP estimates in 1990 Geary–Khamis international dollars at purchasing power parity

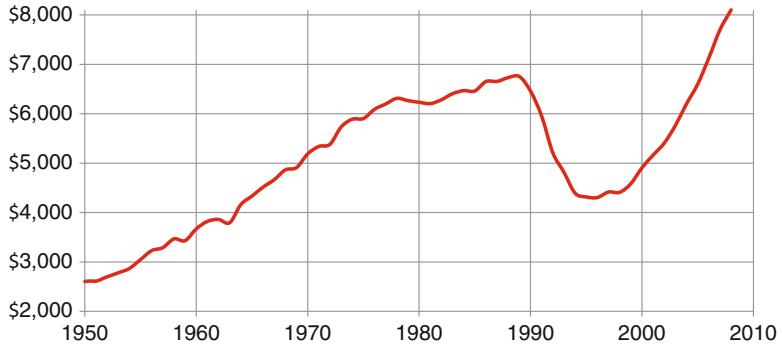


Fig. 3.18 The Second World per capita GDP Dynamics, *1950–2008. Data source*: Maddison (2001, 2010). Note that Maddison provides GDP estimates in 1990 Geary–Khamis international dollars at purchasing power parity

Now let us consider the long-term dynamics of the gap between the First and the Second World as regards per capita GDP (see. Figs. 3.19, 3.20, 3.21, and 3.22).

As we see, in the 1990s in the Second World countries a catastrophic decline of the output was accompanied by an explosive growth of the gap between the First and the Second World, which reached by the mid-1990s an unprecedented level. Note that while by the mid-2000s the Second World managed to return its output to the pre-crisis level, it failed to return the gap with the First World to this level, and by 2008 it remained much higher than it had been observed at any point of time before 1991. The point is that in the 1990s the economic collapse in the Second World was observed against the background of a generally rather fast economic growth of the First World countries, that is why by the moment when the Second

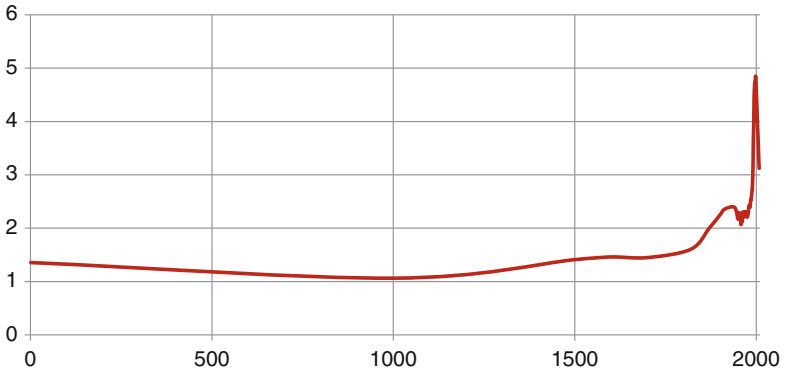


Fig. 3.19 The dynamics of the gap in GDP per capita (by how many times) between the First and the Second World, *1–2008*

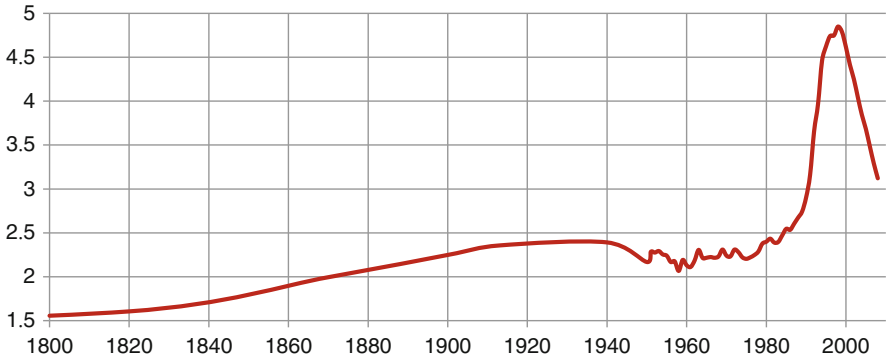


Fig. 3.20 The dynamics of the gap in GDP per capita (by how many times) between the First and the Second World, *1800–2008*

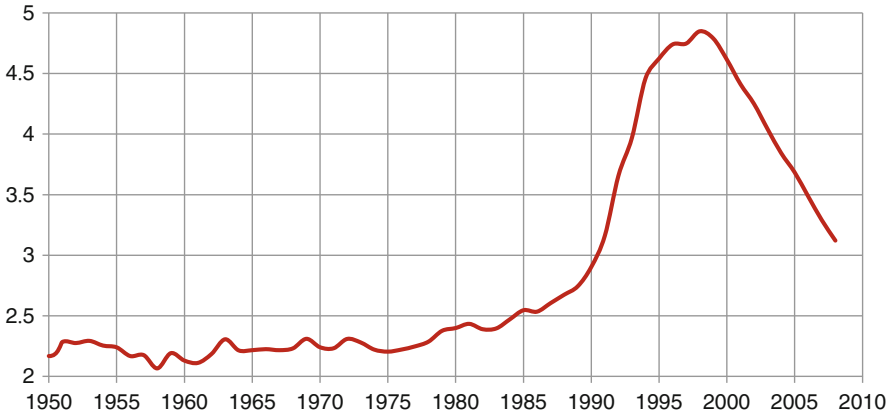


Fig. 3.21 The dynamics of the gap in GDP per capita (by how many times) between the First and the Second World, *1950–2008*

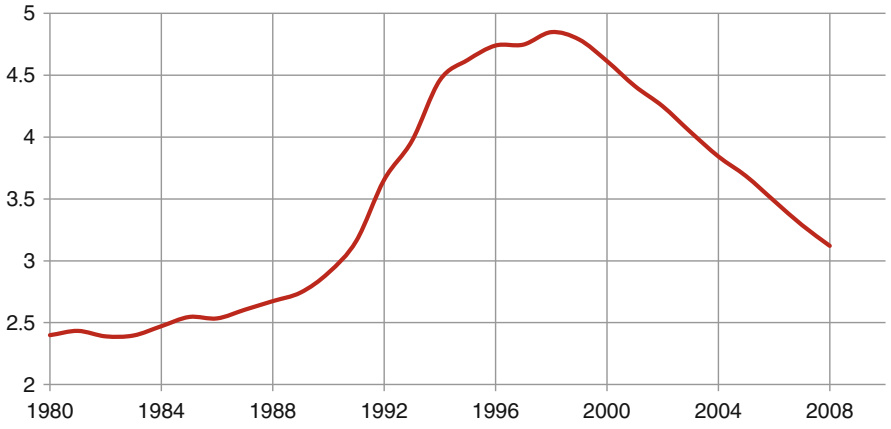


Fig. 3.22 The dynamics of the gap in GDP per capita (by how many times) between the First and the Second World, 1–2008, *1980–2008*

World restored its pre-crisis GDP per capita level, the First World economies had gone far ahead (see Fig. 3.23).

As a result, in the 1990s, the Second World share in the world GDP contracted in a really significant way. As we remember, when we use the World Bank data on the GDP calculated in 2005 international dollars at purchasing power parities, we have an impression that there was almost no convergence as regards the world GDP share in the 1990s (and that such a convergence only started in the 2000s). However, the picture changes very significantly as soon as we separate the Third World from the Second World (see Fig. 3.24).

As we see, after the division of "the Rest" into the Second and Third World we see that a fairly fast convergence between the First and Third World (as regards their shares in the global GDP) already started in the 1990s (with a certain hitch in the last years of this decade). However, these were precisely the early 1990s when a rather significant decline of the Second World's share in the global GDP occurred. Thus, in the first half of the 1990s a rather substantial increase in the Third World's share of the global GDP was almost entirely compensated by the simultaneous decline of the Second World's share (and this is just what creates an illusion of the convergence absence in this period).

Respectively, after the division of "the Rest" into the Second and the Third World, we can see that a rather noticeable convergence between the First and the Third World started in the early 1990s (though with a certain hitch around the end of this decade), see Fig. 3.25.

These were already the 1990s when the developing countries managed to achieve a substantial decrease of the gap with the developed countries as regards the GDP per capita—from the ninefold value to the eightfold. However, a really sustainable and fast reduction of this gap started after 1999, and between 1999 and 2012 it

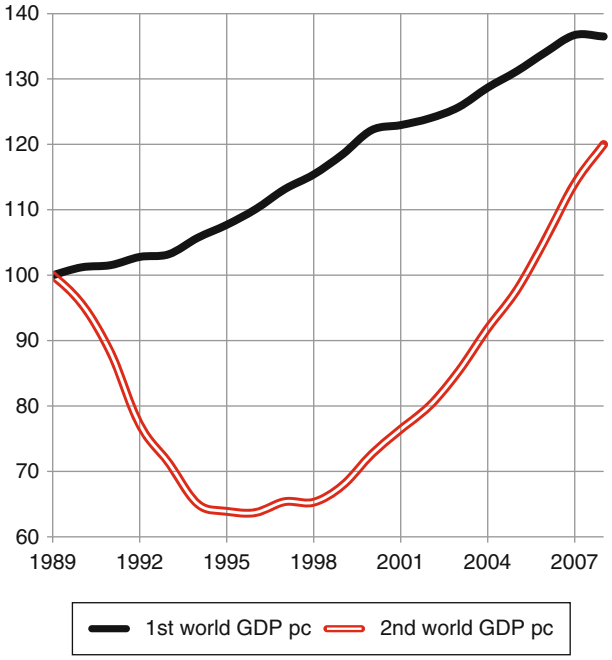
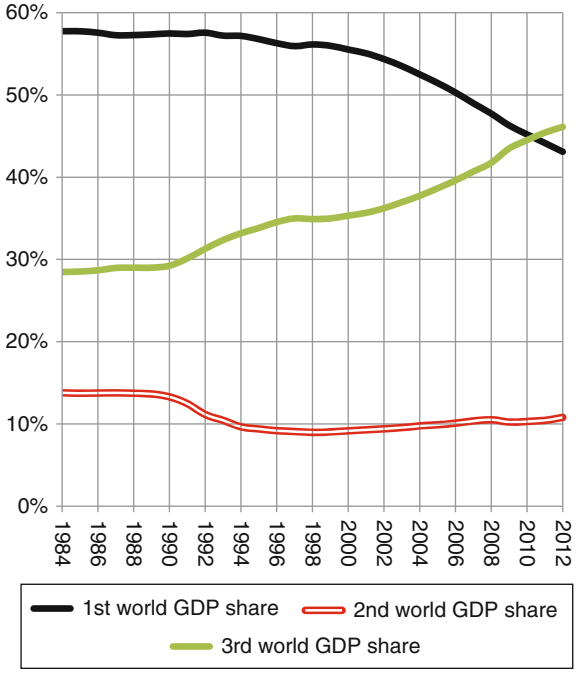


Fig. 3.23 Relative Dynamics of the GDP per capita in the First and Second World, 1989–2008, 100 = 1989 level. *Data source*: Maddison 2010. Note that Maddison provides GDP estimates in 1990 Geary–Khamis international dollars at purchasing power parity

Fig. 3.24 Dynamics of shares of the First, the Second, and the Third World in the global GDP, 1984–2008 (based on the World Bank data on the GDP calculated in 2005 purchasing power parity international dollars). *Data source*: World Bank (2014): NY.GDP.PCAP.PP.KD. The fact that the First World curve in this graph is not entirely identical with the one in Fig. 3.1 is accounted for by the point that in two cases two different aggregation schemes were used



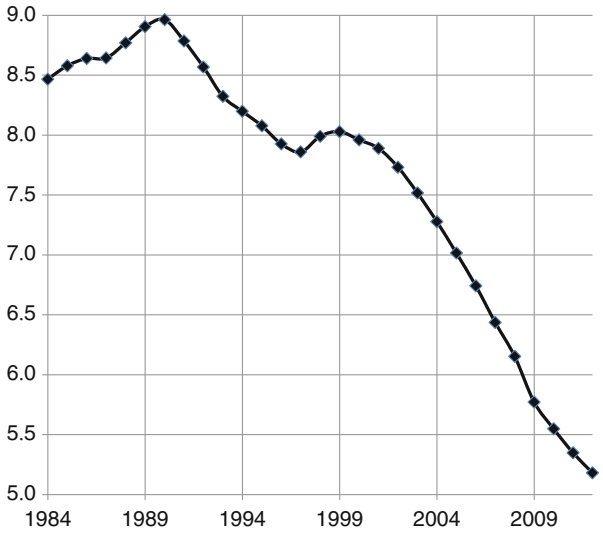


Fig. 3.25 The dynamics of the gap in GDP per capita (by how many times) between the First and the Third World, 1984–2012 (based on the World Bank data on the GDP calculated in 2005 purchasing power parity international dollars). *Data source*: World Bank (2014): NY.GDP.PCAP.PP.KD

shrank from the eightfold to the almost fivefold. If the lessening of this gap continues at the same rate (regarding which one may still express certain doubts in view of both the perspective of the "reindustrialization of the West" and the threat of middle income trap[7] with respect to some Third World leaders) the gap between the developed and developing countries may almost disappear already in 20 years.

The analysis of the dynamics of the gap between the First and Third World with respect to the per capita GDP on the basis of Maddison's database produces results rather similar to the ones obtained above on the basis of the World Bank database. However, this is only Maddison's database that allows considering this dynamics in a deep historical perspective. In a two-millennia perspective it looks as follows (see Fig. 3.26).

Consider now the dynamics of the gap between the First and Third World at the scale of centuries and decades (see Figs. 3.27 and 3.28).

As we see, the gap between the developed and developing countries continued to grow up to the 1960s; in the 1970s it somewhat contracted, but in the 1980s it grew again. Curiously, these were just the 1990s when the Western economist undertook a massive examination of the convergence issue (see, e.g., Barro 1991; Bianchi 1997; Canova and Marcet 1995; Desdoigts 1994; Durlauf and Johnson 1995; Lee

[7] For more details on this trap see *Statistical addendum* below, or, e.g., The World Bank and the Development Research Center of the State Council of the People's Republic of China (2012: 12) and Гринин et al. (2014).

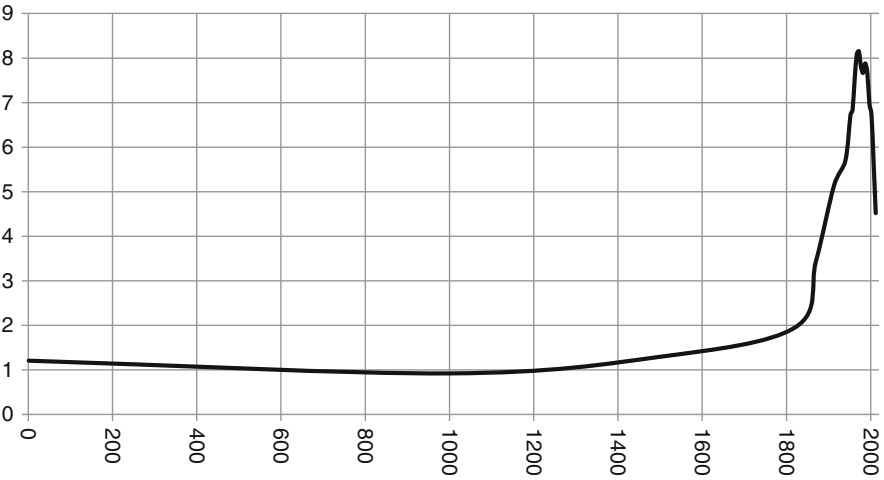


Fig. 3.26 Dynamics of the gap in GDP per capita (by how many times) between the West (the First World) and the Third World, *1–2008*

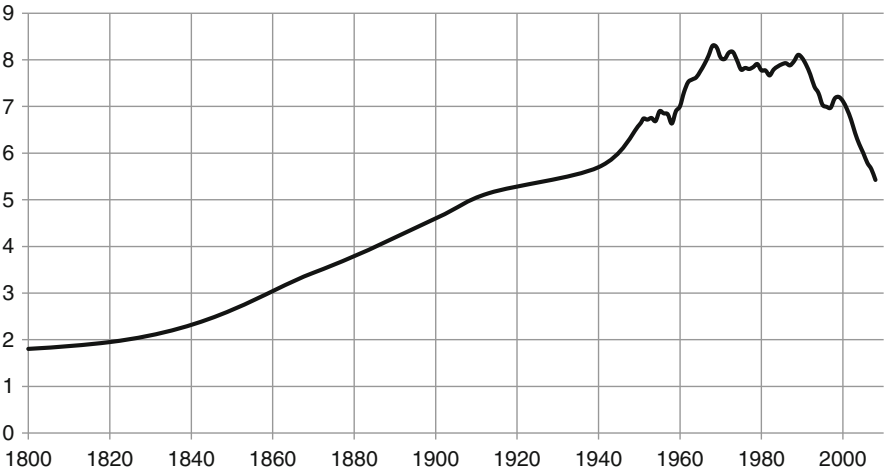


Fig. 3.27 Dynamics of the gap in GDP per capita (by how many times) between the West (the First World) and the Third World, *1800–2008*

et al. 1997; Mankiw et al. 1992; Paap and van Dijk 1994; Quah 1996a, b, c, 1997; Sachs et al. 1995; Sala-i-Martin 1996—see the next chapter for a detailed review of those publications). The most widespread method of this examination was to compare the gap in the 1950s and 1960s (on the one hand) with, on the other hand, the most recent data points (which, naturally—as the examination took place in the

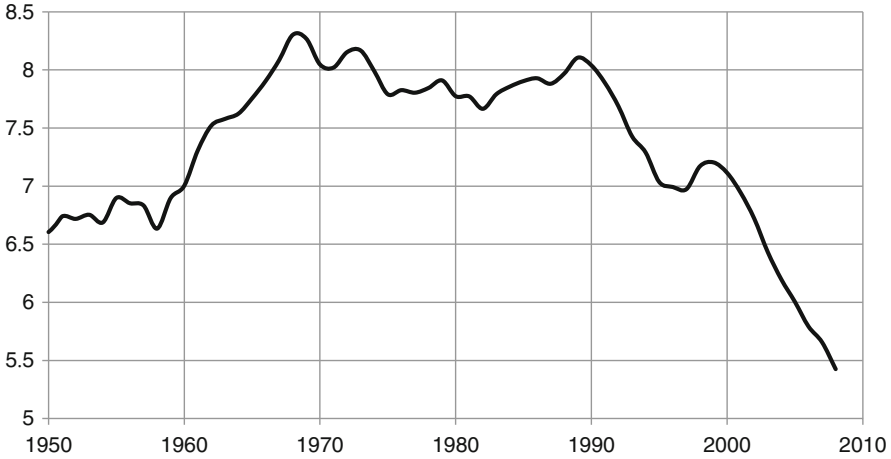


Fig. 3.28 Dynamics of the gap in GDP per capita (by how many times) between the West (the First World) and the Third World, *1950–2008*

1990s—corresponded to the late 1980s and early 1990s).[8] As one can easily guess on the basis of Fig. 3.28, such a scrutiny led Western economist in a rather systematic way to an apparently well-grounded conclusion that there was no convergence between the developed and developing countries at all—one would rather speak about a continuing divergence (albeit a rather weak one). Note that a rather sound theoretical basis for such a conclusion had been established by that time by Paul M. Romer's (1986) theory of "increasing returns", which implied in a rather clear manner that the gap between poor and rich countries should in future increase rather than decrease. Indeed, Romer wrote that the model of increasing returns offered "an alternative view of long-run prospects for growth" that was contrary to the assumptions of convergence theory: "per capita output can grow without bound, possibly at a rate that is monotonically increasing over time. The rate of investment and the rate of return on capital may increase rather than decrease with increases in the capital stock. The level of per capita output in different countries need not converge; growth may be persistently slower in less developed countries and may even fail to take place at all" (Romer 1986: 1003).

Yet, as is suggested by the very Fig. 3.28, rather paradoxically, just in that very time when the Western economists arrived almost unanimously at the conclusion

[8] The most wide-spread way to operationalize such a comparison looked as follows—the idea was to identify the correlation between the per capita GDP levels in various countries of the world in 1950/1960, on the one hand, and the GDP per capita growth rates between 1950/1960 and 1990, on the other. Quite logically, within such an operationalization scheme, a significant negative correlation was rather soundly interpreted as evidence for the presence of global convergence, a significant positive correlation was as soundly interpreted as evidence for the presence of global divergence, whereas an insignificant correlation was interpreted as evidence for the absence of both global convergence and global divergence.

that there was no convergence between the developed and developing countries, that very convergence was already gaining momentum![9]

Statistical Addendum to This Chapter: On the Structure of the Present-day Convergence[10]

First, let us view the dynamics of the gap in GDP per capita between the high-income OECD countries and the low-income countries for the past three decades (see Fig. 3.29).

One can see that the gap between the high-income OECD countries and the low-income countries kept growing until 2000. All in all, between 1981 and 2000 this gap increased very significantly, from 25 times in 1981 to almost 40 times (however, one should note here that, though the gap was still widening in the late 1990s, this enlargement proceeded at a much slower pace as compared to the previous years). In the 2000s, the gap started to contract rather fast, decreasing from 40 to 30 times during only 12 years. Abstractly speaking, if this trend and pace persist, the gap will essentially disappear in about three decades; though, of course, there are strong doubts whether the low-income countries ["the bottom billion" as coined by Paul Collier (2007)] will manage to keep up the current fast pace of catch up the high-income countries in terms of GDP per capita.

Let us now turn to the dynamics of the gap in GDP per capita between the high-income OECD countries and the middle-income countries in the past three decades (see Fig. 3.30).

Thus, the gap between the high-income and middle-income countries kept growing until 1990, approaching the value of 10 (which means that the GDP per capita in the high-income countries exceeded that in the middle-income countries by an order of magnitude). After 1990 one can observe a rather pronounced trend for this gap to decrease. However, during the 1990s the gap was decreasing rather slowly, going down from the value of 9.25–8.7 within a decade. In the 2000s the gap continued decreasing at a more accelerated pace, going down from 8.7 to 5.4 during 12 years (2000–2012).

Finally, let us view the dynamics of the gap in GDP per capita between the middle-income countries and the low-income countries in the past three decades (see Fig. 3.31).

Some important observations can be made at this point. Indeed, both the middle-income (after about 1990) and the low-income (after about 2000) countries seem to have been converging to the high-income countries in the latest years (as compared

[9] We think, that this fiasco of the Western economic science was connected with the fact that Western economists tried to apply basically linear models to the analysis of a highly nonlinear process.

[10] This Addendum has been prepared on the basis of our article "On the structure of the present-day convergence" (Korotayev and Zinkina 2014).

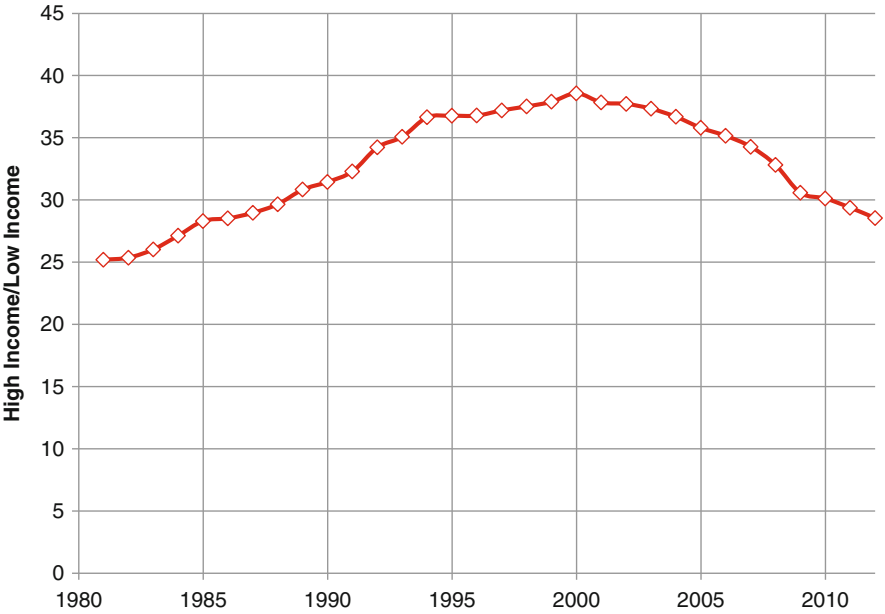


Fig. 3.29 Dynamics of the gap in GDP per capita (from here on we use 2005 constant international dollars, PPP) (by how many times) between the high-income OECD countries (According to the World Bank classification, this group of countries includes Australia, Austria, Belgium, Canada, Chile, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Japan, Korea, Rep.; Luxembourg, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom, United States.) and the low-income countries (According to the World Bank classification, this group of countries includes Afghanistan, Bangladesh, Benin, Burkina Faso, Burundi, Cambodia, Central African Republic, Chad, Comoros, the Democratic Republic of Congo, Dem. Rep.; Eritrea, Ethiopia, the Gambia, Guinea, Guinea-Bissau, Haiti, Kenya, North Korea, Kyrgyzstan, Liberia, Madagascar, Malawi, Mali, Mozambique, Myanmar, Nepal, Niger, Rwanda, Sierra Leone, Somalia, South Sudan, Tajikistan, Tanzania, Togo, Uganda, Zimbabwe.), 1981–2012. *Note*: The *figures* on the Y-axis scale denote by how many times the average GDP per capita in the high-income OECD countries exceeded the one in the low-income countries for a given year. Thus, the value of 25 for 1981 means that in 1981 the GDP per capita was 25 times higher in the high-income OECD countries than in the low-income countries. Calculations made on the basis of the data presented by: World Bank (2014): NY.GDP.PCAP.PP.KD

to the divergence trend observed in the previous decades).[11] However, at the same time the low-income countries have been diverging from the middle-income countries for the whole period of the latest three decades. Thus, the gap between these two groups of countries has been steadily growing for the latest 30 years; the GDP per capita in the middle-income countries exceeded that in the low-income countries by three times in 1981; now this gap is more than fivefold.

[11] Notably, the change from divergence to convergence trend first occurred in the middle-income countries, and then (10 years later) in the low-income ones.

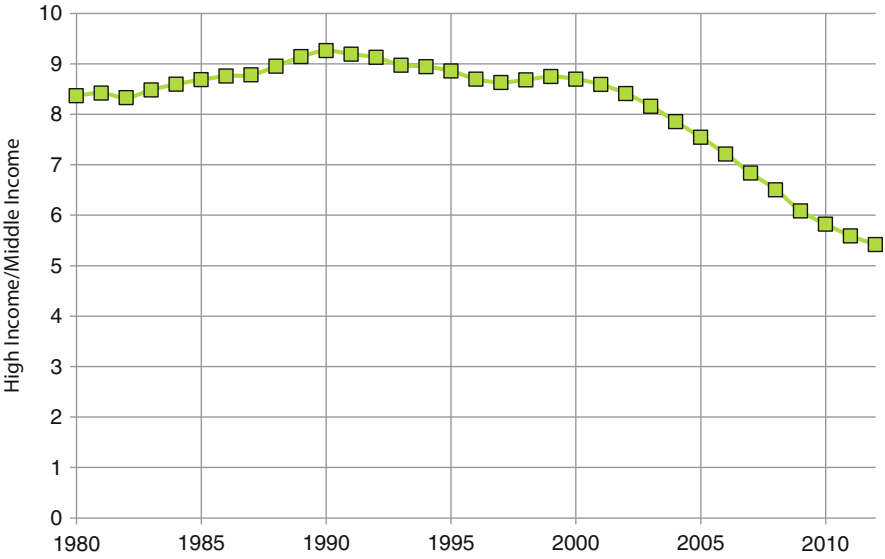


Fig. 3.30 The dynamics of the gap in GDP per capita (by how many times) between the high-income OECD countries and the middle-income countries (according to the World Bank classification, this group of countries includes Albania, Algeria, American Samoa, Angola, Antigua and Barbuda, Argentina, Armenia, Azerbaijan, Belarus, Belize, Bhutan, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Bulgaria, Cameroon, Cape Verde, Chile, China, Colombia, Congo, Rep.; Costa Rica, Cote d'Ivoire, Cuba, Djibouti, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Fiji, Gabon, Georgia, Ghana, Grenada, Guatemala, Guyana, Honduras, India, Indonesia, Iran, Islamic Rep.; Iraq, Jamaica, Jordan, Kazakhstan, Kiribati, Kosovo, Lao PDR, Latvia, Lebanon, Lesotho, Libya, Lithuania, Macedonia, Malaysia, Maldives, Marshall Islands, Mauritius, Mexico, Micronesia, Moldova, Mongolia, Montenegro, Morocco, Namibia, Nicaragua, Nigeria, Pakistan, Palau, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Romania, Russian Federation, Samoa, Sao Tome and Principe, Senegal, Serbia, Seychelles, Solomon Islands, South Africa, South Sudan, Sri Lanka, St. Lucia, St. Vincent and the Grenadines, Sudan, Suriname, Swaziland, Syrian Arab Republic, Thailand, Timor-Leste, Tonga, Tunisia, Turkey, Turkmenistan, Tuvalu, Ukraine, Uruguay, Uzbekistan, Vanuatu, Venezuela, Vietnam, West Bank and Gaza, Yemen, Zambia.), 1981–2012. *Note*: The *figures* on the Y-axis scale denote by how many times the GDP per capita in the high-income OECD countries exceeded that in the middle-income countries for a given year. Thus, the value of 9 for 1993 means that in 1993 the GDP per capita was nine times higher in the high-income OECD countries than in the middle-income countries. Calculations made on the basis of the data presented by: World Bank (2014): NY.GDP.PCAP.PP.KD

Thus, the general pattern of convergence and divergence between the high-income, middle-income, and low-income countries during the last 30 years looks as follows (see Fig. 3.32).

Our finding is quite concordant with some of the results presented in previous publications. Thus, Ho (2006) studies the threshold effects of per capita income on the convergence behavior of growth rates among 121 economies during the sample period from 1960 to 2000. Convergence appears to be insignificant in the lowest-income regimes, but is significantly found beyond such regimes. Ho finds the income threshold (which the country needs to overcome in order to start converging) to be

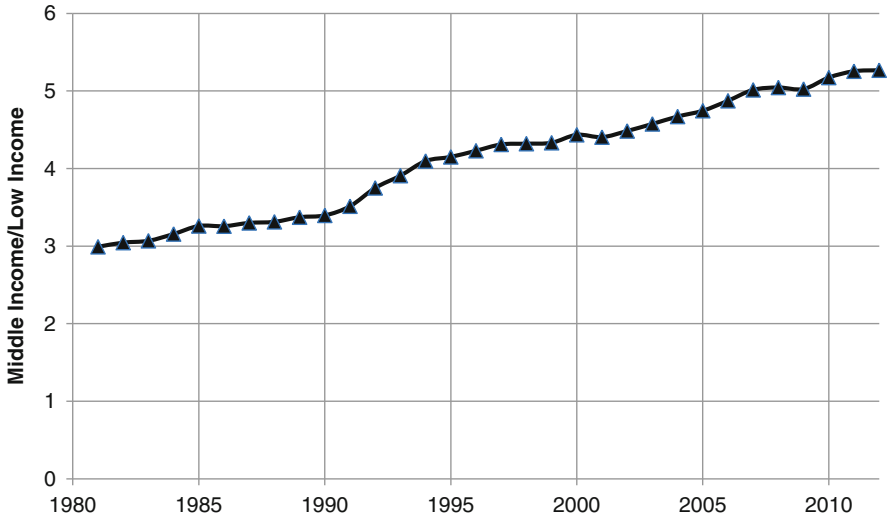


Fig. 3.31 The dynamics of the gap in GDP per capita (by how many times) between the middle-income countries and the low-income countries, 1981–2012. *Note*: The *figures* on the Y-axis denote by how many times the GDP per capita in the middle-income countries exceeded that in the low-income countries for a given year. Thus, the value of 4 for 1994 means that in 1994 the GDP per capita was four times higher in the middle-income countries than in the low-income countries. Calculations made on the basis of the data presented by: World Bank (2014): NY.GDP.PCAP.PP.KD

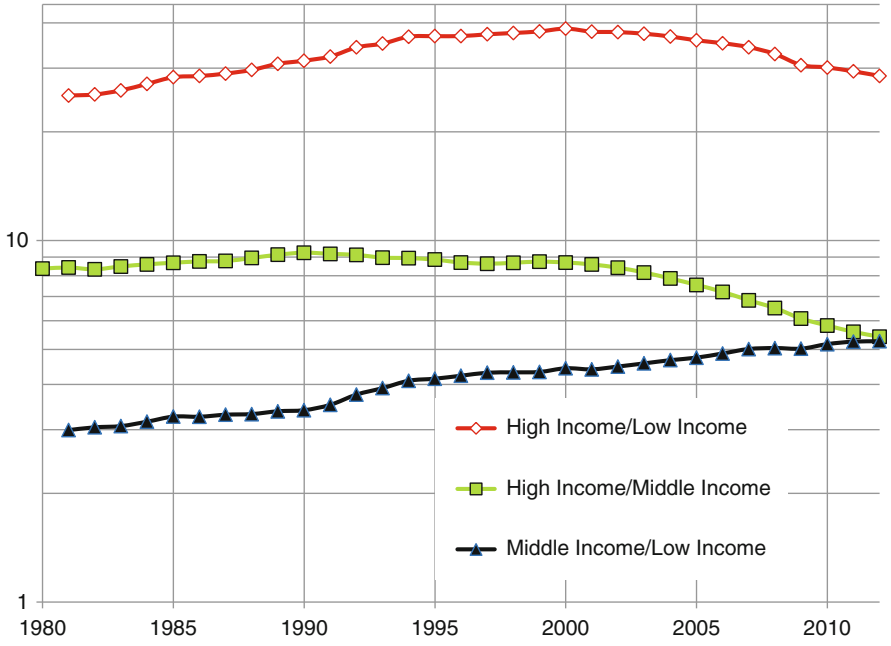


Fig. 3.32 The dynamics of the gap in GDP per capita (by how many times) between the high-income, the middle-income, and the low-income countries, logarithmic scale, 1980–2012

about $1,150. Malamud and Assane (2013) investigate the growth difference between sub-Saharan Africa/SSA (which make up the majority of the lowest-income group viewed by Ho and the low-income group investigated in this paper) and the rest of the world and find that SSA countries converge more slowly, if at all, than the rest of world countries over the period from 1965 to 2000. Our results seem to be well consistent with the findings stated in both papers.

Possible Explanations of the Trends

Now let us turn to analyzing the forces and factors behind the above-revealed specific pattern of the dynamics of per capita income gaps between the high-income, middle-income, and low-income countries. Naturally, in a single paper one can hardly present a comprehensive explanation (or even an attempt at making the one) for the complex structure of convergence trends. So below, we will try to outline only some main economic forces that are likely to have contributed to the specific convergence-divergence pattern of recent years. Let us start with the two fundamental convergence-driving forces proposed by Gerschenkron and Solow (as quoted above), namely, the technological diffusion from the more advanced countries to the developing ones, and weaker diminishing returns in the developing countries.

As regards the technological diffusion, it is likely to proceed particularly fast in the middle-income countries that have a sufficient amount of well-qualified workforce (including labor force with professional technical education) which is essential for a successful practical implementation of the adopted technologies. Indeed, a number of studies demonstrate that in order to benefit from international technology transfers, the learning capacity as well as the investment required to apply technologies in local production processes, play an important role (see, e.g., Nabin et al. 2013; Hoekman et al. 2005).

Now let us briefly view the possible influence of another major convergence-driving factor, namely, the larger marginal product of capital and investment profit in the developing countries as compared to the more affluent societies. Abel and Bernanke took this principle implied in the Solow model as a basis to expect a more rapid increase in capital stock in poor countries (Abel and Bernanke 2005: 234).

Indeed, already in 1998, the proportion of investment in GDP was much higher in the middle-income countries than in the high-income ones (notably, this proportion was the lowest in the low-income countries)—see Fig. 3.33. By 2008, the proportion of investment in GDP remarkably dropped in the high-income countries and simultaneously grew in the low-income ones; so the low-income countries actually outpaced their high-income counterparts with respect to this indicator. However, the middle-income countries experienced the greatest increase in the proportion of investment in GDP during the same period and by 2008 they far outpaced both the high-income and the low-income countries (see Fig. 3.34).

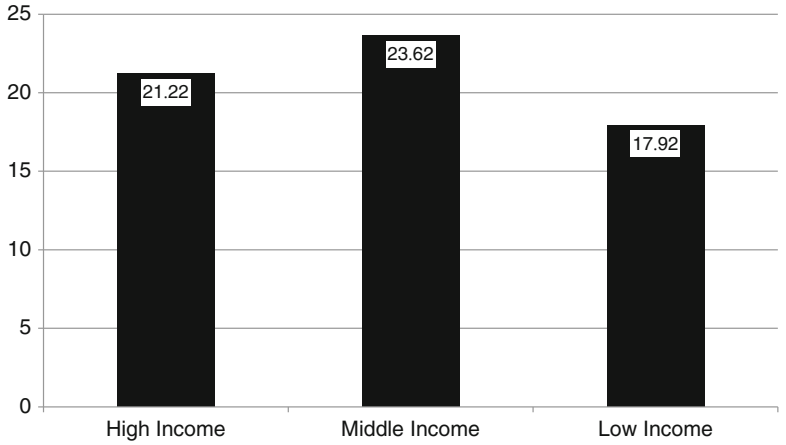


Fig. 3.33 Proportion of investments in GDP, %, 1998. *Note*: calculated on the data from World Bank (2014): NE.GDI.FTOT.ZS

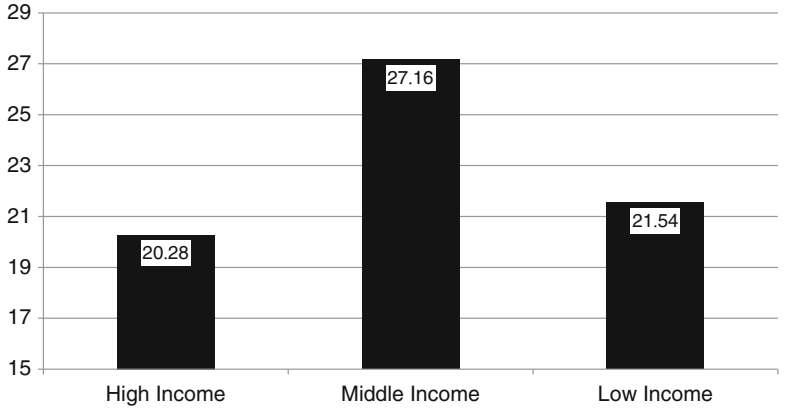


Fig. 3.34 Proportion of investments in GDP, %, 2008. *Note*: calculated on the data from World Bank (2014): NE.GDI.FTOT.ZS

Foreign investment inflow into the developing countries contributes to convergence in various ways. Generally, it has a significantly positive direct effect on the growth of income per capita (e.g., Alfaro et al. 2004; Blonigen and Wang 2005; Borensztein et al. 1998). Moreover, FDI has a significantly positive direct effect on TFP growth, which is extremely important, as more than half of the cross-country variation in both income per capita and its growth rates results from the differences in TFP and its growth, respectively (for a detailed review see Woo 2009).

This taken into account, the particularly high economic growth rates in the middle-income countries are clearly not coincidental.

Possible Global Implications of the Convergence–Divergence Pattern

Thus, in recent years the structure of convergence-divergence pattern has become rather peculiar. The gap between the high-income and middle-income countries has been rapidly decreasing. This fact is particularly noteworthy when taking into account that the middle-income countries currently accommodate about 70 % of the world population (about five billion people). If the current pace persists in the nearest decades, the prospects for these 70 % look really bright, as the gap between the high-income OECD countries and the middle-income countries will essentially disappear in just 15–20 years. However, such a bright prospect of the middle-income countries fully converging to the high-income ones is very doubtful with a view to the prospect of the "Reindustrialization of the West", on the one hand, and the "middle-income trap"[12] awaiting the middle-income countries, on the other. Indeed, a number of Latin American countries were the first to experience stagnation after reaching middle-income levels and failure to move further into the ranks of high-income countries. A number of works reveal the same threat to be currently looming large for many developing countries in other regions, notably in Asia (including China) (see, e.g., Grinin and Korotayev 2010a; Kohli and Mukherjee 2011; Cai 2012; Kharas and Kohli 2011; Aiyar et al. 2013). Note also that the mathematical model presented above in Appendix B also predicts a certain slow-down of the processes of Great Convergence in the forthcoming decades. One should not exclude the possibility of temporary reversals (similar to the one that was already observed in 1997–1999).

The gap between the high-income and the low-income countries has also been decreasing lately, but at a much slower pace. Meanwhile, the gap between the middle-income and the low-income countries has been growing steadily. In the early 1980s, this latter threefold gap was clearly outshadowed by the colossal gap (almost a tenfold one) between the high-income and the middle-income countries. The current situation is remarkably different: the low-income countries lag behind the middle-income by more than five times, which is almost equal to the gap between the middle-income and the high-income countries.

As regards the low-income countries, we would like to emphasize that their total population does not exceed a billion people (World Bank 2014: SP.POP.TOTL), which is less than the total population of the high-income countries. In other words, "the bottom billion" is currently less than "the golden billion". This means that when looking at the convergence and divergence processes in terms of the population numbers in the converging/diverging countries, we are bound to state that currently the processes of convergence clearly prevail over the processes of divergence (much more people live in the converging countries than in the diverging ones). However, this disposition is likely to dramatically change in the coming decades, as

[12] As defined by Aiyar et al., the "middle-income trap" is "the phenomenon of hitherto rapidly growing economies stagnating at middle-income levels and failing to graduate into the ranks of high-income countries" (Aiyar et al. 2013: 3). For a detailed description of the factors and mechanisms of the middle-income trap see, e.g., Kharas and Kohli 2011.

the population growth rates in the "bottom billion" are much higher than in the rest of the world. Indeed, the African populations have recently been growing more rapidly than the non-African developing world grew *at its peak*, and that by 1970, the ratio of young dependents to the working-age population had exceeded historical developing-country norms and even now remains that high (Ndulu et al. 2007: 106; Zinkina and Korotayev 2014). A decade of economic successes has been hardly enough to bring many countries just to the WHO recommended level of per capita food consumption; however, if the fertility decline fails to accelerate and population continues rocketing up, to sustain this level (let alone to surpass and start to catch it up, which is utterly essential for improving the living standards of the majority of population) is likely to become "mission impossible" (Zinkina and Korotayev 2014; Зинькина and Коротаев 2013).

Thus, our analysis reveals a rather significant re-configuration of the World System in the recent three decades. It is namely the middle-income countries that have demonstrated the highest economic growth rates after 1990 (and even more so after 2000). This is quite explicable, as in the modern world namely the middle-income countries generally have the best opportunities for achieving high economic growth rates. Indeed, the workforce in such countries is still rather cheap (as compared to the high-income ones), but already benefits from rather high levels of education and health system, which greatly increases the quality of the workforce (as compared to the low-income countries). The low-income countries, on the other hand, are lagging behind in terms of education (especially secondary and tertiary education) and still demonstrate extremely high population growth rates which increase the age-dependency ratio and decreases the economic growth rates. While the middle-income countries have been converging to the high-income ones, the low-income countries have actually been diverging from the middle-income ones. This is a rather threatening trend which requires specific international attention to removing the growth obstacles in the low-income countries (among other things, by increasing the education level and the quality of the workforce, as well as by bringing down the extreme population growth rates).

Chapter 4
The Great Convergence and Globalization: How Former Colonies Became the World Economic Locomotives

After the Great Divergence reached its peak level between the 1850s and the 1870s, more than a century had passed before a new trend became apparent in the world economy development; that was a tendency towards convergence. Still, retrospectively one can already trace the beginning of this process in the nineteenth century when Europe's and the West's domination seemed to have become overwhelming. Strange as it may seem, the main reason for such a change was the necessity to support Western economic development as well as the trend in divergence, that is to increase the export of capital and technologies to the countries which would later become developing ones and this, in its turn, encouraged both the growth of national movements for political and economic independence and also the rise of the stratum of entrepreneurs with new business ethics.[1] In the late nineteenth and early twentieth centuries, the increasing export of British and European capital also marked the initial formation of the contemporary World System. From the late nineteenth century, the World System core began to move from Great Britain to the USA (see Гринин and Коротаев 2009в; Grinin and Korotayev 2012c, 2013a for details); but before this transfer was finally completed, there were hard crises of the first half of the twentieth century which also made it easier for the colonies to gain political independence.

[1] This became evident rather soon (see, e.g., Marx 1853).

L. Grinin, A. Korotayev, *Great Divergence and Great Convergence*,
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Western Technologies and the Emergence of Prerequisites for a Shift Toward Convergence in the Late Nineteenth and Early Twentieth Centuries

Increasing Export of Capital as a Starting Point of the Turn The emergence of steam transport and development of electric communications brought opportunities of the fast transfer of capital and goods. Combined with free trade policy, this led to a rapid growth of external trade and export of capital in the world. The latter also affected less developed countries, yet one could hardly speak about any equal trade. In the period from the 1850s to the 1870s, the average growth rate in world trade was about 5 % (Held et al. 1999); moreover, in the nineteenth century its general growth surpassed the industrial production growth (see, e.g., Широков 1981: 39). An intensive railway construction in the USA and in a number of other countries (including Argentina, India, Australia, and Russia) was the driving force of global development for at least last two or three decades of the nineteenth century and was impossible without foreign capital involvement. On the whole, the role of Great Britain as the main exporter of capital (followed by France) was exceptionally important. It was exactly the export of capital that "cooled down" the British economic upswings starting from the last quarter of the nineteenth century. During the 20 years (from 1862 to 1882), according to some evidence (Hobson 1902), the outflow of British capital grew six times. To a great extent the export of capital took place in the form of foreign loans. According to some estimates, by 1881, British capital had invested into the foreign government obligations a huge sum of money for those days, namely, 700 million pounds (Hobson 1902; see also O'Rourke and Williamson 1999: 209 etc.). On the whole, between 1870 and 1914, British net export of capital totaled £2,400 million, which in large part flowed to the underdeveloped countries (Sweezy 1969: 194). But in the 1870s, for each 100 million of British capital sent abroad, there were already 60–70 millions of French capital also being sent abroad (Мендельсон 1959, т. 2: 14). In that period (as well as in the subsequent one), in addition to Great Britain and France, Germany also became a capital exporter and its role tended to increase (Гинцберг 1970: 433–434), while the USA, Italy, Russia, and Japan absorbed foreign investments (see Мельянцев 1996: 114–115; see also Amsden 2004; Allen 2011).

In the subsequent period, large-scale foreign investments of different kinds became the most important locomotive of global development, and in the periphery countries as well. Thus, during the period from the 1880s to the 1890s, Great Britain, France, and Germany doubled their foreign investments. During the economic cycle of 1881–1893, the foreign investments almost equaled the investments for the entire previous history of these countries (see Мендельсон 1959, т. 2: 305; см. также Rippy 1959). "This continuous and increasing emigration of capital from the countries with the old capitalist culture presented a factor of utmost importance in the matter of distribution of the capitalist economy throughout the world. It was just due to the flow to emerging economies that capital conquers one country after another

in our days: emigrating capital remains a capital and brings everywhere the new economic mode" (Туган-Барановский 2008 [1913]: 273; see also Tugan-Baranovsky 1954). This process, already evident in the late nineteenth and early twentieth century, intensified even more in the first half of the twentieth century. For example, before the Second World War the volume of European, American, and Japanese investments in South-East Asia amounted to no less than 3.2 billion dollars (Васильев 1977: 175; Hall 1955; see also Amsden 2004: 108).

Railroad track mileage in Asia and Africa doubled in the 1890s (Мендельсон 1959, т. 2: 385). By the beginning of the First World War, some 35,000 km of railways were built to the South of the Sahara (Allen 2009). The beginning of the twentieth century was marked by a twofold increase of the railway construction in non-Western countries (i.e., in Latin America, Africa, Asia, Canada, and Australia etc.). Aside from the USA and Europe, during the 7 years between 1900 and 1907, there were built 72,000 km of railways (calculated by Мендельсон 1959, т. 3: 33; see also Amsden 2004). On the whole, by the beginning of World War I, the length of the railway network in a number of countries, which later would form the Third World, was rather considerable. Thus, India's rail net was about 56,000 km; this is larger than in Great Britain and France and almost equal to the length of railroads in Germany. In Brazil, Mexico, and Argentina the length of the railroad network was 24.9, 25.5, and 33.2 thousand kilometers respectively (Мельянцев 1996: 130).[2] According to the estimates by such scholars as Issawi and Maddison, between 1870 and 1914, the volume of foreign capital (in constant prices) invested in the Third World countries grew by 5.3–5.5 times and the investments were made mostly in infrastructure and the mining industries (Issawi 1981; Maddison 1989; see also Rippy 1959; Amsden 2004). Communication lines (like river and ocean shipping, telegraph etc.) also developed rather actively together with, say, about 6,000 miles of highways built in British Burma by 1938 (Hall 1955). The financial system was created [as well as banks and other institutions (about Indochina, Java see *Ibid.*)].

The investments in the infrastructure of periphery countries increased their exports, although the periphery still remained mostly a supplier of raw materials and some agricultural products (see, e.g., Гуревич 1986), and to a lesser degree it was also a supplier of industrial natural resources and fuel [like copper, lead, tin, iron and other metals, sulfur, saltpeter, oil etc. (Hall 1955; Rippy 1959; Yergin 1991)]. In 1870–1928, in India, China, and Brazil the export in physical expression annually grew by 2–3 %, while in Indonesia and Argentina it grew even more—by 4.5–5 %.[3] And in Korea, although it was exploited by Japan, even higher rates of industrial growth were registered: in 1900–1929 the growth was 10.5–11.5 % (van der Wee and Blomme 1992; Amin 1970; Maddison 1989; Morris and Adelman 1988; Perkins 1969; Amsden 2004).[4] However, during the Great Depression many

[2] Due to this, already in the last decades of the nineteenth century wheat and meat (the latter due to the invention of refrigerators) from Uruguay and Argentina managed to gain the European markets; and Chile started an active export of copper and guano.

[3] In value terms the export from Indonesia in 1850–1914 grew by 13 times (Гуревич 1986: 66).

[4] During World War II, the Korean industry gave as much as one-third of all materials and products needed by Japan (Пак 1986: 472).

developing countries suffered from a sharp decrease of trade volumes. However, in the 1870s–1920s and especially in the years of World War I, the terms of trade index of the periphery countries supplying raw materials and agriculture products also grew (Asselain 1985: 272; Bairoch 1992: 410; Perkins 1975: 34; Goldsmith 1986: 54–55; Hansen and Lukas 1978: 431; Heston 1983: 903–904; Issawi 1982: 39; Leff 1982: 82). The demand for raw materials (especially for some of the products such as rubber or jute) in the Western countries was rather large.

As noted, the appearance of new technologies, assets and goods as well as the attempts to modernize Eastern societies led to the emergence of local industries, bourgeoisie and proletariat, in other words, brought about rather important social and economic changes. But, in our opinion, of utmost importance is the emergence of local intelligentsia aware of western values and knowledge systems; this led to the emergence of a number of large-scale social movements of the early twentieth century in Turkey, Iran, China, India, the Philippines, Egypt etc. Although the remaining countries were still rather backward, the East, nevertheless, started moving within the general global trend and becoming more closely involved in the World System. It is also worth noting that in the second half of the twentieth century the progress proceeded more rapidly in exactly those countries of the future Third World where various changes in modernization did occur (however weak and often contradicting the countries' interests they may have seemed).

The Political Crisis in the Western Countries and Political Rise of the Peripheral Societies By the beginning of the twentieth century, the opportunities for territorial expansion of the West were almost exhausted. Meantime, a vigorous development of the Western economies was combined with increasing contradictions between them. This escalated into a confrontation that launched two murderous world wars which significantly reduced the importance of Europe in both the global economy and global politics. As has been mentioned earlier, powerful social revolutions and movements took place, and they changed the Western countries' social policy. While the role of Europe was decreasing, the might of the USA as the major country of the Western world increased and finally, after World War II, one could observe a political consolidation of countries headed by the USA in the struggle against Communism. Of course, at the beginning of the twentieth century it was really impossible to imagine that 50 years later there would hardly remain any remnants of the huge colonial empires. Similarly, at the beginning of the nineteenth century, one could hardly imagine that half a century later the world would be a network of railways and telegraph lines. In the world of industrial economy and constant innovations 50 years is rather a long period.

The export of most up-to-date technologies, an active development of agricultural production of essential basic stuff, the acquaintance of the colonial countries' elites with Western education, the growth of local entrepreneurship (e.g., Amsden 2004), and weakening of Western countries as a result of wars and crises—all these led to the strengthening of the political liberation movement (e.g., Grenville 1994). As has been mentioned above, this created a new situation. On the one hand, in the interwar period, the Western governments increased their efforts (at the same time

enhancing the humanitarian trend) to preserve their political domination; on the other hand, their activity was also enhanced by the rising national consciousness (see von Albertini 1971, 1982 for the different influence of European countries, changes in respect of the rule of colonies, nationalist elites etc.). Besides, some other countries' influence increased and their example (in the first place that of the USSR and Japan) inflamed minds. It is enough to read Jawaharlal Nehru (Nehru 1949) to see that the idea of active industrialization with state intervention to eliminate backwardness in the shortest period of time had penetrated the political leaders' minds. Later, practice showed that using only domestic and state resources could hardly help to achieve this end (However, without considerable efforts on the part of the state, this could hardly occur either.). Thus, the idea of self-enhancement that originated in the most developed eastern countries first as means to create a strong modern army, later started to actively penetrate the political elites' minds, though already on a wider basis, as a concept of societies' deep modernization. Nevertheless, one can hardly ignore the fact that this idea often had to oppose the ideology of the unique path of certain countries and civilizations combined with the preservation of old institutions. For example, Mahatma Gandhi (and far from him alone), basing his thinking on his ideal of small-scale industries, was against "machine civilization" thinking that machines would bring evil. Thus, in his famous book "*Hind Swaraj*", he maintained that "today machinery merely helps a few to ride on the back of millions" (Gandhi 1998). Of these same views was the Iranian thinker, Ahmad Kasravi (for details see Дробышев 1986: 246–247). But even such leaders had to admit the necessity of industrialization.

Many peripheral countries participated in the two world wars as allies of the respective imperial centers. This brought certain changes in colonial and semi-colonial countries especially during the Second World War. While the First World War had hardly touched many of them, the Second World War, in particular, the Japanese expansion, affected many more countries. For example, the British dominions and protectorates were actively involved in this struggle. That led to a vigorous rise of national consciousness (see, e.g., Юрьев 1994: 3–12). Besides, it is known that the weakening of the West launched a wave of anti-colonial struggle which led to the emergence of several dozens of independent states within two decades. The intellectuals in these societies were full of bright hopes that their societies would flourish shortly after, but economic welfare appeared a long way from political independence. Nevertheless, the world had significantly changed. Its configuration became completely different. It began to comprise three worlds, consisting of the developed Capitalist (the First), Socialist/Communist (the Second) and developing (the Third) World segments. But we should note that such a division was only defined in these terms in the 1950s.[5]

[5] Let us note that the term "Third World" itself was initially introduced as a political (military-political) term denoting the countries that did not join any military-political blocks (mind that far from all developing countries were non-aligned countries) and only later the term "the Third World" started to denote developing countries. Thus, originally, the Third World could only resolve political issues, and the convergence itself meant just choosing the path of convergence (Capitalist or Socialist/Communist).

West and East After the Second World War: Technologies and Politics

The Scientific-Information Revolution. A New Rise of the West. Pessimism Towards the East Contrary to the hopes of the Socialist Prophets after the Second World War, the Western countries not only managed to escape a permanent crisis, but having recovered, they demonstrated unprecedented growth rates. This happened, on the one hand, due to profound transformations in the Western societies connected with an increasing role of the state in social and economic regulation and with the elimination of discrimination of different layers of the population (Grinin 2012a). On the other hand, Western societies managed to extract advantages for the starting scientific-information revolution.[6] No wonder that just in that period, an especially concentrated cluster of innovations emerged. The share of new products was rather large in the World System core economies. Thus, according to the estimates by *McGraw-Hill*, in 1970 the share of new products, which appeared in the market after 1952, in the US industrial output in the machinery manufacturing sector this amounted to 85 %, in electrical engineering—97 %, in car industry—77 % (Клинов 2006: 87). On the whole, by the end of the 1960s, the share of engineering and chemical industries in the US manufacturing output exceeded 56 % (Клинов 1992: 177, 179–180).

Between 1950 and 1970, this revolution revealed itself in a vigorous development of synthetic materials' production, in the introduction of automation into manufacturing, in the development of biotechnologies which allowed the production of new drugs, nutritional and livestock supplements, and in numerous other changes in most industries. The non-computer electronics and communication means were also actively developed (for more details see Grinin 2012a; Grinin and Grinin 2013). Finally, the invention of the first computers in the 1940s and 1950s contributed to the information revolution in subsequent decades a revolution that changed practically everything. The Western economy became a service economy (Bell 1973; Hartwell 1976; Toffler 1980; see also Gibson 1993; Krahn et al. 2008). Meanwhile, the Western societies achieved an unprecedented level of living standards. The affluent society had come true.

In the meantime, the Third World countries also underwent huge changes. In addition to the development of enhanced independent statehood in these countries, the major changes consisted in the demographic transition that started in most of those countries and was connected with the introduction of modern medical service. As is known, this led to outstanding population growth rates in those countries and in the world in general. The rates of natural population increase in the developing countries grew from 1.3 % in the 1940s to 2.54 % in 1971 (calculations are based on Maddison 2010; similar estimations see, e.g., Широков 1981: 83; UN Population

[6] For a long time it has been denoted as a "new industrial revolution" or a "scientific-technical revolution" etc. (see, e.g., Bernal 1965; Philipson 1962; Benson and Lloyd 1983; Sylvester and Klotz 1983).

Division 2014; for details see Appendix B). One can state that it will be definitely impossible to achieve the population growth rates which were observed in the 1960s and 1970s again. Thus, the leading evolutionary trend of the previous millennia, which we defined earlier (in Chap. 2) as the major indicator of development, reached its maximum point in the 1970s and started gradually decreasing. One can consider just that period as a critical point after which the global trend of the Great Divergence started transforming into the Great Convergence. Why? First, the non-Western world had finally maintained its advantage on labor resources (which some time later became more evident), while the Western world had almost achieved its maximum rate of labor resources. Second, a gradual decrease of the birth rate in the developing countries in the 1990s meant that in the non-Western countries the level of development of human capital had significantly increased and started the transition to the modern economic model (for details on this point see Appendix B).

However, not all such transformations were evident and some were presented as having apocalyptical outcomes. It seemed impossible to catch up with the Western states because of their huge development rates. It is not surprising, that in the period after 1950, the dependent development theory became rather popular in Latin America and among leftist economists in the West—Hans Singer, Raúl Prebisch, Fernando Henrique Cardoso, Enzo Faletto, Celso Furtado etc. (see e.g., Prebisch 1950, 1959; Cardoso and Faletto 1979; Furtado 2003, 1999; see also Toye and Toye 2003).[7] This theory was applied, in particular, to Latin American countries which passed through several waves of modernization but still lagged behind the developed countries.[8] The general idea within this approach is that the world economic system is organized in a way that gives substantial advantages to the developed countries in trade and other transactions with respect to the developing ones (in particular, in the form of non-equivalent export) which generate inequality and permanent backwardness of the latter.[9]

Yet, contrary to all the predictions of many of the above mentioned (as well as other) experts (e.g., Prebisch 1959; Bairoch 1964; Sunkel 1966; Wallerstein 1974, 1987; Amin 1976, 1994, 1997; Bornschier 1976, 1981, 1982, 1983; Bornschier and Chase-Dunn 1985; Frank 1979; MacPherson and Midgley 1987; Love 1980; etc.) who in the 1950s, 1960s, 1970s, and 1980s wrote about practically unbreakable vicious circles of backwardness of the developing countries, two or three decades later the real situation in many of them appeared rather optimistic.

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[7] Of course, we do not mention different socialist and communist ideas that were rather popular in the 1950s and 1960s among some Western economists according to which the monopolistic Capitalism and real progress of underdeveloped countries are completely incompatible (e.g. Dobb 1963a, 1969; Feinstein 1969).

[8] In contemporary economic literature this phenomenon was also called the end of the standard model of modernization (e.g., Аллен 2013; Allen 2011).

[9] These ideas got their further development within the world-system theory (Frank 1979; Wallerstein 1987; Arrighi 1994). The dependency theory as a concept has generally lost its value, but some of its important ideas are used this way or another by contemporary scholars (James 1997; Köhler and Tausch 2002; see also Бобровников 2004; Хорос and Красильщиков 2001; Красильщиков 2011).

Nevertheless, as we will see below in Appendix B, already in the 1950 and 1960s the Third World generally caught up with the First World in terms of GDP growth rates, and then the progress of the Third World accelerated. Thus, there was an increase in the rate of investment from 6–8 % of GDP in 1900–1938 to 21–23 % of GDP in 1950–1993 (Мельянцев 1996: 220; об этих, а также и последующих периодах см. также Мельянцев 2000, 2009, 2013). The developing countries also began to surpass the developed countries in terms of changes in development indices (*Ibid.*). In short, these countries achieved modern growth rates and other indicators of growth, but in order to reduce the gap they had to make a more vigorous breakthrough. The Third World's lagging behind the First in terms of the per capita GDP growth rate in the 1960s and the 1970s was connected first of all with the fact that at that period most developing countries had not yet entered the second phase of the demographic transition. Meanwhile, the enormous backwardness of the developing countries in comparison with the developed ones concealed the most important positive change: namely, that the developing countries started to advance much faster than they used to, and this was especially manifested in the development of human capital (however poor the actual situation was, but medicine, education and culture had progressed very much in these countries). Actually, the developing countries' lag was evident only in comparison with the progress of the developed ones; but in fact, in many of them profound changes had occurred, and besides, the economic growth rates (in particular, the growth rate of export volume), as well as the HDI growth rates had already surpassed the preindustrial value and reached contemporary ones.

On the whole, in the Third World, the share of people living below the poverty line reduced from 45–50 % in 1960 to 24–28 % in 1990 (Мельянцев 1996: 199). The literacy rate of the adult population which in 1900 was about 14–15 % increased from 28 % in 1950 to 69 % in 1993, and the average number of years of study increased from 1.6 to 5.8 (see, e.g., Bairoch 1983; Мельянцев 1996). Besides, child mortality in the developing countries also declined at a fast rate (from 200 to 70 ‰ in 1950–1993). On the whole, then the general improvement of economic and sanitary situations in the Third World contributed to the increase in average life expectancy, which in 1950–1993 increased almost two times from 35 to 64–66 years (Мельянцев 1996: 199; World Bank 2014).

But of course, the development of the Third World was rather contradictory, since a rather pronounced backwardness was still evident and in some regions grievous poverty and misery even increased; besides, the development was also non-uniform, as alongside with some countries' progress, the others could even fall farther behind. This non-uniformity was present both among countries and within certain countries where some regions resembled developed areas while the others remained very backward.

The developing countries have also demonstrated a diversity of pathways and patterns of economic development (Грановский 1988: 314). Not all of them proved to be a success, but that was the way to gain the necessary experience of development as well as to give a boost to some of their economic sectors. Thus, the Soviet scholars distinguished the following modes of economic growth in India's development

before the 1980s: (1) economic stabilization (by the mid-1950s); (2) imbalanced industrialization (from the mid-1950s to the mid-1960s); (3) the promotion of agriculture (from the mid-1960s to the mid-1970s); (4) development limited by internal market dynamics (from the mid-1970s) (Грановский 1986: 140).[10] Let us also note that in the 1960s one could observe a very fast growth of heavy industry in the developing countries. The average annual growth rate in heavy industry was 8.4 %, while in light industry it was 4.8 % (UN Department of Economic and Social Affairs 1973: 17; Бабинцева 1982: 24). This tendency, but already with a smaller gap, endured even in the 1970s. This was in itself quite important for the emergence of national economies despite the later developed ideas that it was actually of no importance which sector of economy developed if it worked rather efficiently (for the criticism of this idea see Reinert 2007). But since many of those enterprises were state-owned, they often turned unprofitable. Thus, the TNCs became another important and more effective way to develop technologies.

Finally, in the 1970s and 1980s the most effective export-oriented models of development were elaborated (see Amsden 2004). However, we should note once again that in the 1970s and even 1980s, those retrospectively visible changes were undetected, while on the surface one was used to observing increasing poverty, unemployment and economic lag (real and apparent, primarily with respect to the GDP per capita) behind the Western countries. It was worse that many economists were convinced that such backwardness was impossible to overcome, because of the fallaciousness of the world economic system itself. But as is typical of evolutionary processes, when a trend achieves its most visible outlines, it means that it has already exhausted itself; but this fact was not yet evident to a superficial observer. Both the problems of the South and the wealth of the West showed evidence for a turn toward convergence. First, this turn toward convergence evidently appeared in the small Asian Tigers' success (Berger 1986), and later—in the larger countries' advance.[11]

[10] This period is recognized to bring a serious crisis which became possible to overcome after the reforms of 1991, after which the growth rates in India accelerated. Granovsky (Грановский 1986: 134) distinguished three components of the economic policy in the developing countries in the 1960–1980s, namely, declarative, compensatory and structurally reforming components. The declarative component comprised planned objectives not supported with resources and opportunities. It was just the tasks of that kind that would frequently exhaust the weak economy and lead to crises. The compensatory impact was most clearly manifested in credits (often ineffective) of the small-scale manufacturing. But on the whole, the reformative and purposeful activity of the young states led to development.

[11] The Asian Tigers and sometimes such Latin American countries as Argentina, Mexico, and Brazil are regarded as first newly industrialized country (NIC). The next generations of NIC include Malaysia, Thailand, India, Chile, Cyprus, Tunisia, Turkey, Indonesia, the Philippines, and China. The term "newly industrialized country" came into use around 1970. There are some criteria for NIC (in particular, the combination of an open political process, comparatively high GNI per capita, and a thriving, export-oriented economic policy, substantially high Human Development Index). However, different economists disagree both on the list of such countries and on the criteria (e.g., Bożyk 2006: 164; Guillén 2003: 126; Waugh 2000: 563, 576–579, 633, 640).

Together with the process of current globalization and general technological advance, the periphery became actively involved in the global technological process. The attempts to attract capital and technologies became more and more intensive, and active work started in order to create conditions for this. The Great Convergence was coming.

The Beginning of the Turn to Convergence: Causes and Manifestations

The "rise of the rest" was one of the phenomenal changes in the last half of the twentieth century (Amsden 2004: 2). However, one can hardly speak about any single reason which appeared as a determinant in the change of the vector of development from the Great Divergence to Great Convergence. If the task was to define the most important reason, then, in our opinion, it would consist of the fact that the process of the growing connectedness of different countries which was aimed at supporting further innovative development sooner or later would demand the equalization (at least to a certain degree) of developmental levels of different regions of the world. One can call this a "law of communicative vessels" in global economy. Up to a certain moment this law did not work to its full extent as there were some social and cultural, technological, and political impediments for its implementation. As is demonstrated in Appendix B, the most important among them was the low level of the human capital development in the World System periphery which did not allow any really effective diffusion of capital and technologies from the World System core.[12] But those impediments would almost inevitably weaken, and then the backward regions would start to develop faster simply due to the influence of more developed countries. Below we will dwell on this point in detail.

Nevertheless, similar to the case with catching up divergence, it is more appropriate to speak about a range of reasons. Below, we will enumerate a number of additional factors and causes which led to the situation where the growth and development rates of the Third World countries ultimately surpassed those of the First World. Unfortunately, we have no opportunity to dwell on each cause in detail. That is why we limit ourselves to a brief enumeration which will be accompanied with additional comments to some of the aspects. Since any hierarchy of causes would be rather ambiguous, we will place them in chronological order to as much an extent as possible.

[12] On the other hand, the level of the human capital development was as high as in Western Europe in such its agricultural and raw material suppliers as Canada, Australia, and New Zealand—and West European capitals and technologies diffused there without any problems, bringing them quite easily to the club of the most developed countries of the world. Throughout most other peripheral countries it was much lower, and the enormous problems that the Western industrial capital encountered when trying to diffuse to the peripheral countries with low levels of the human capital development are very vividly described by Clark (2007: 303–370).

Fundamental Reasons

Political and Ideological Reasons and Factors

The Role of the USA From the very beginning, the USA (having quite a few colonies of its own) was much more determined than France and Great Britain as regards that peoples deprived of independence should gain it and that even having colony status, the peoples of the latter have the right to claim a fairer distribution of wealth. This position supported the struggle for independence of many colonies. For example, Franklin D. Roosevelt sharply criticized Britain for the eighteenth-century methods of trade with colonies. He believed that they should use the twentieth-century methods which involved bringing industry to the colonies, increasing people's welfare by increasing their living standards, by educating them, by bringing them sanitation, by making sure that they would get a return for the raw wealth of their community (Рузвельт 1947: 230–233). Of course, later the United States did not hesitate to use the methods of the past centuries, if it turned out to be profitable, but some factors (listed below) would prevent this. To sustain their own image as the most democratic country and to manipulate voting in various international organizations the USA also supported the developing countries in different ways.

The Growth of the Military and Political Significance of Developing Countries This significance increased during the Second World War, and this increase resulted from the conflict between Capitalism and Communism, the formation of military blocks, the deployment of military bases, etc. In some way, this growth demanded from the West (and from the Communist Bloc as well) technical, military, financial and other support be given to the periphery countries, consequently bringing up the Third World countries to a higher level of development. The ideological and political conflict between Capitalism and Communism contributed to the fact that the Western countries had to increase their various forms of support, especially to the countries in strong confrontation with the Communist Block. And exactly those countries succeeded to make early breakthroughs (Taiwan, Hong Kong, South Korea). This support was also provided to other countries which for some reason turned out to be important for the West, for example to maintain balance in the Middle East, Latin America, in the former colonies, etc. The significance of the ideological factor (the responsibility of the West, its guilt), and of the general humanitarian component (which had prepared the background for the mobilization of the society to help developing countries) also increased.

The Role of the USSR and the Communist Countries was quite significant with respect to industrial modernization and the transfer of technology which led to the formation of heavy industry in some Third World countries. The USSR and other Communist states supported different countries, many of which (India, Egypt, etc.,) accepted state industrialism but refused to accept Communism. The result was the enhancement of important steps in the industrial development of those countries.

Aspects of International and Regional Organizations

The Role of Developing Countries due to Their Number Was Especially Tangible in Various International Organizations Thus, the assistance to developing countries had been intensified through international organizations and was performed on a scientific basis with the involvement of the leading experts. In short, the West had to realize the necessity of bringing up the developing countries to reduce the gap. The Western countries were not interested in the developing countries catching up with them, but they were interested simply in reducing the gap. That is why the most grievous forms of backwardness such as hunger, tribal warfare, long civil wars, and complete disregard of modernization (education, medical aid, etc.) were considered highly undesirable or simply intolerable and were mostly eliminated.

The Role of Regional Organizations Within framework of the regional organizations it was easier to assimilate new experience, to get certain aid, to adopt a new ideology and certain standards, and to negotiate with the Western countries. Despite the fact that regional international organizations in developing countries as well as the association of developing countries with the Western countries (within the Commonwealth framework, contacts with EU etc.) were not entirely efficient, they still contributed to problem solving.

The Growing Variety (and Rivalry) of Development Programs Many different models of modernization appeared after many countries gained independence during the conflict between Capitalism and Communism and regional struggle (e.g. in the Middle East). Due to this great variety, there were many opportunities for the implementation of some alternatives and their successes. And the successful pattern could be reproduced.

Economic Reasons and Factors

The Growing Significance of Developing Countries as Suppliers of Industrial Mineral Resources and Agricultural Raw Materials (timber, agricultural commodities, minerals, fuels, etc.).

In the nineteenth century cotton was the most important raw material for European industry, later its place was taken by natural rubber and then by oil. While coal deposits were abundant in European countries, the oil reserves were limited. Furthermore, the dependence on oil supplies grew more and more. The struggle for oil within the framework of economic expansion started in the 1920–1930s with the most illustrative case of Mexico which nationalized the oil companies. Nationalization remained the most important event after the war and often alternated with the overthrows of the governments that aimed at nationalization (the most illustrative case is Iran in the 1950s). At the same time, the significance of the oil countries (or countries possessing some other strategic raw materials) was growing.

The Second World War demonstrated the importance of having oil. That is why during and immediately after the Second World War the Middle East became a strategically important region. Saudi Arabia started to be the USA's significant focus and was considered as a valuable foreign investment. It is not surprising that in 1950 President Harry S. Truman wrote a letter to the King of Saudi Arabia which reads as follows: "No threat to your kingdom could occur which would not be a matter of immediate concern to the United States" (Yergin 1991). Thus, the USA began to establish a strategic partnership with Saudi Arabia (and later with the states of the Gulf) rather long ago. The year, 1960, became an important landmark in the development of oil-producing countries as that year the Organization of the Petroleum Exporting Countries (OPEC) was established in Baghdad. The founders of the organization were Iran, Iraq, Kuwait, Saudi Arabia, and Venezuela. OPEC became the most powerful supranational organization of developing countries after the oil price shocks in 1973–1974 and 1979–1980, and these oil price shocks marked the turning point in the relations between the developing and developed countries. As a result, for the first time in history the developing countries surpassed the developed ones with respect to oil production and therefore, the Third World countries' economic activity for the first time led to a global economic crisis.

For many countries increasing oil production eventually paved the way to growing welfare, to inflows of capital, and even to convergence. In the 1970s, oil generally became a symbol of the third-world countries' growing opportunities in relation to the West. Of course, the allocation of oil revenues remained inefficient for a long time (and the situation still persists), but nevertheless, in many developing countries oil revenues are the major source of accumulation of capital and this allowed implementation of important reforms in agriculture, education, healthcare, etc. This particular situation is observed in many countries, and their number constantly grows [among relatively new oil-exporting states are Angola, Chad, Cameroon, Equatorial Guinea, there are large prospects for Kenya and Mozambique (with respect to gas) as well as for some other countries].

Progress in Agriculture due to the Green Revolution and the Aid from Developed Countries The inability to provide enough food for their rapidly increasing population was one of the main problems in the developing countries. Different measures were taken to solve this problem (e.g., application of new scientific and technological achievements in agronomy), and some of them (like levelling land allocation or the formation of cooperatives of the Soviet type) failed to contribute to the agriculture efficiency in a number of countries. But on the whole, the developing countries made a great step forward in solving this issue. Among the most efficient measures was the Green Revolution, which involved a number of changes in the agriculture of developing countries in the 1940s, 1950s, 1960s, and 1970s and led (and still leads) to a significant growth of agricultural production (Thirtle et al. 2003; Pingali 2012).[13] The Green Revolution involved the use of the

[13] Norman Borlaug has contributed significantly to producing new varieties of plants. The term "Green Revolution" was introduced by William Gaud, the former Director of the United States Agency for International Development (USAID).

achievements in genetics, selection, and the physiology of plants for the active development of high-yielding varieties, using fertilizers, pesticides, and modern techniques. Another component of the Green Revolution was irrigation already familiar to the Asian countries, which with the beginning of the Green Revolution received special attention in a number of countries. The point is that many new varieties of grain crops could produce high yields only in the conditions of good water supply.

The impact of the Green Revolution expanded beyond developing countries, but for such countries as Mexico, Korea, India, Pakistan, Indonesia, Sri Lanka and some others it appeared to be of particular importance. These are mostly countries with dense populations where wheat and rice constitute the basic ration. The rapid growth of their populations led to a further increasing pressure on agricultural land which was already overcropped. In the situation of free land scarcity and prevalence of the small and even the smallest farms using old farming practices, in the 1960s and 1970s more than 300 million families in these countries were hard pressed, being on the edge of starvation and some were even hit by constant famine (Стопа 2010). That is why Green Revolution was considered in these countries to be a realistic endeavor to overcome this critical situation. New varieties of rice and other cereals were developed—with characteristics best suited to specific conditions of certain countries (Philippines, India, etc.) which greatly outyielded the old varieties. In China during the Song dynasty (the tenth to thirteenth centuries) high-yielding and early-maturing rice varieties were introduced which (in combination with a few other factors) finally (by the nineteenth century) led to an extraordinary (even for today) population growth from *c.* 40 million up to 400 million people (see, e.g., Ho 1956; Perkins 1969: 38; Shiba 1970: 50; Bray 1984: 491–494, 598; Korotayev et al. 2006b: 54–64). During the Green Revolution, a rapid technological progress in agriculture was observed in most of the Third World; meanwhile, at that time the first Green Revolution passed China by (whereas actually this country was suffering from famine resulting from the Communist experiments) and it was only three decades later that the achievements in agriculture and plant breeding were successfully applied in China. Over all, the progress was outstanding and impressive. Thus, during 5 years from 1966 to 1971, the rice production in Ceylon, India, and Philippines grew by 60 %, the wheat production in India increased by almost 2.5 times, the corn production in Morocco more than doubled (Стопа 2010). On the whole, during the last 50 years the developing world witnessed an extraordinary period of food crop productivity growth, despite increasing land scarcity and rising land values. Although populations had more than doubled, the production of cereal crops tripled during this period, with only a 30 % increase in land area cultivated (Wik et al. 2008; Pingali 2012). Between 1960 and 2000, yields for all developing countries grew by 208 % for wheat, by 109 % for rice, by 157 % for maize, by 78 % for potatoes, and by 36 % for cassava (FAO 2004; Pingali 2012). At the first stages of the Green Revolution its third component (namely, the industrialization of agriculture which implies the use of farm mechanization, chemical fertilizers, insecticides and pesticides) was realized to a lesser extent, as it required much more time for implementation. But the advance in this field became more noticeable in the

1980s and 1990s and is still ongoing. On the whole, in the second half of the twentieth century, the agricultural production in Asia grew by 4.8 times, and population—by 2.6 times (Потапов и др. 2008: 41; see also Wik et al. 2008). The most significant progress in the development of the agricultural sphere has been made in Republic of Korea, Thailand, Taiwan, and the People's Republic of China (as already noted—since the 1980s). Thus, for example, in Thailand from 1950 to 2000, the volume of agricultural production increased by almost seven times (Королев 2003: 590–592; see also Swaminathan 1993; Evenson and Gollin 2003; Thirtle et al. 2003; Renkow and Byerlee 2010; Ecker et al. 2011; Bideleux 2014).

Let us note that the Green Revolution is generally dated from the establishment of the Mexican Agricultural Program by the Rockefeller Foundation in 1943. Norman Borlaug is known to succeed in developing numerous highly-productive wheat varieties including layering-resistant ones. By 1951–1956, Mexico became fully self-sufficient at cereal production and began exporting it to other countries, because during a period of 15 years the crop capacity tripled there. Borlaug's main achievements were used in plant breeding in Columbia, India, and Pakistan; he was awarded the Nobel Peace Prize in 1970.

In 1963, the International Maize and Wheat Improvement Center (CIMMYT) was established on the basis of Mexican research institutions, and this institution made a primary contribution to the spread of the Green Revolution. It is no coincidence that the Green Revolution originated in Mexico as the USA was really interested in improving the food security of this neighboring country (One should recall that the Philippines was a colony of United States up to 1946; that is partly why the Philippines have also become a country where Green Revolution was a success.). Thus, the collaborative efforts of the developed and developing countries as well as that of the international agricultural research centers and national research programs are evident in the Green Revolution (Evenson and Gollin 2003). This emphasizes the fact that the Western countries are not simply involved in the Convergence, but it is to a very considerable extent due to their efforts (and to a larger extent to their corporations' activities).

The General Role of Developing Countries in the Context of Intensifying Contacts and Increasing Interdependence Between Countries The increasing immigration to the Western countries from the Third World required control over epidemics in developing countries, as well as fighting against drug trafficking, and coping with other negative factors. It became of vital importance to realize that the explosive increase of populations in developing countries should be taken under control. For this purpose different programs and reforms in education, welfare, health service, agriculture, and many other spheres were developed.

The Workforce Decline in Western Countries and actually expanding job opportunities for immigrants from developing countries (the source of accumulation, information and currency flow) also played some role.

The Role of Transnational Corporations (TNCs) The TNCs play the leading role among numerous factors and agencies that contribute to globalization, global

integration, technological transfer, and the development of infrastructure, as well as contributing to the development of modern economic patterns in the Third World countries, which allowed those countries to be involved in international labor division. Transnational corporations became the networks that connect countries, institutions and different firms, and were also responsible for the new technologies, commodities, services, views, etc.[14] For the first time in history, the backward countries industrialized without proprietary innovations (Amsden 2004; in this book see also about the role of multinational firms in technology transfers in different countries). An especially rapid growth of transnational corporations was observed in the 1950s and 1960s and coincided with the period of formation of newly independent states which provoked numerous conflicts. In 1971, the volume of foreign production of TNCs already exceeded the export volume of the developed countries (note that in the specified period the activity of most TNCs was conducted in developed countries, yet the share of developing states grew specifically in the field of oil and minerals extraction). As a result, the studies of TNCs as well as of international business and foreign investment generally became rather popular in the literature of the 1970s (e.g. Barnet and Muller 1974; Weinshall 1975; Gilpin 1975; Buckley and Casson 1976; Wallace 1976; Hood and Yong 1979). Though most of the economists considered the results of TNCs' activity as positive, nevertheless, opinions of their activity in the mass media and in different countries were quite contradictory. This should come as no surprise. Similar to old-time organizations which through achieving their own peculiar aims (of a variety of kind from egoistic to noble ones) had become the instrument of progress, the TNCs, pursuing their own interests, had become one of the most important forces capable of changing the ideas about sovereignty and the role of national borders (see e.g. Vernon 1971; Strange 2003; see also Grinin 2008b, 2011b, 2012c). The TNCs (similarly to the past-time forces) have both positive and negative sides; but that is the essence of development, which is a side effect of the powerful forces actively achieving their objectives. Egoistic interests of TNCs (together with the egoism of the ruling groups and elites) used to cause numerous conflicts, crises, revolutions, coup d'états, and defaults in many periphery countries. In a number of cases, the conflict between national governments and TNCs was rather acute (on the one hand, acts of nationalization and expropriation, on the other hand, bribery, and neglect of national problems resulting in military takeovers). Both sides justified the confrontation ideologically: by the right of the state or the people's will, by the primacy of technological progress, and by the sanctity of private property. Barnett and Muller believed reasonably that transnational corporations themselves were generated by "the planetary transformation", but at the same time they contributed to its development. However, in justifying the actions of TNCs, they would require too much for them, in particular, to grant them the right to disregard and transform national states (Barnet and Muller 1974: 18–19). Then the relationships between TNCs and national states improved, as

[14] Their role as well as a contradictory nature of the results of their activity can be compared with the activity of East Indian companies of the seventeenth and eighteenth centuries in terms of establishing contacts between Europe and Asia.

unlike many other historical agents, TNCs appeared to be rather flexible, and they scaled back their ambitions and thus addressed the concerns over state sovereignty. At the same time, the struggle for promotion of corporate social responsibility intensified which also contributed to the adjustment of the interests of societies and corporations in various countries.[15] In their turn, the states learned to more or less control TNCs. Thus, if in the 1950–1970s TNCs primarily established their branches in developed countries, but in the 1980s they started to actively establish them in developing countries. As a result, one can hardly overestimate the significance of the corporations for the rapid development of Third World countries.

The Scientific and Technological Progress Together with Changing Technological Modes Can Be Considered as an Important Reason of the Shift to Convergence Especially starting from the 1980s when an active phase of the so-called deindustrialization of the West began. Deindustrialization can be defined as a decline in the share of industry in the GDP of the countries of the West, as well as in employment in manufacturing. The process of deindustrialization actually started in the mid-1960s, first in the USA; however, in Japan and Europe this process lagged behind. The share of manufacturing employment in the USA declined from 28 % in 1965 to 16 % in 1994. In general, in developed countries the share of manufacturing employment declined from 28 % in 1970 to 18 % in 1994 (Rowthorn and Ramaswany 1997). At the same time, the share of services employment rapidly grew. However, this phase of deindustrialization was mainly connected not only with a transfer of industrial technologies to developing countries or the preferential establishment of new factories there, even though the process was under way (see Amsden 2004) but also with the rapid growth of other economic sectors including information production and services. For this reason, many economists mistakenly believed that North–South trade had very little to do with deindustrialization and with the growing share of low-skilled workers in the developing countries (Lawrence and Slaughter 1993; Krugman and Lawrence 1994; Krugman 1996; Bhagwati 1995). Later the researchers had to admit that in this respect the role of external trade with low-wage economies showed some signs of strengthening in the 1990s and early 2000s (Debande 2006).[16] On the whole, the rapid growth of the service sector, including complex and qualified services (e.g. informational, medical, financial, etc.) together with the extension of free trade, free capital transfer (see below), strict environmental laws, demographic deterioration in the countries of the First World, and the growth of the human capital development level in the Third World made the transfer of production to peripheral countries more profitable.

So, the initiation of the active phase of deindustrialization turned out to be an active phase of industrialization in many developing countries. Let us point out once again that TNCs played the most important, actually a defining, role in this process,

[15] For contemporary views on different aspects of activity and efficiency of TNCs, see e.g. Baily and Solow (2001), Ghoshal and Westney (2005), Mtigwe (2006), Wild et al. (2008), Lewis (2004) and Zerk (2011).

[16] For the analysis of the waves of scholarship in the studies in deindustrialization, change of vectors of researchers' interests and estimations during the last 40 years see High 2013.

as under free-trade conditions it was more profitable and even simply necessary for them (in order to produce competitive products) to substitute high-paid workers of their own countries with the low-paid workers from the developing countries. As a side note, this slowed down the development of robotics which was actively developed in the 1960s, 1970s, and 1980s. Since the productivity in services grew less rapidly than manufacturing productivity (Rowthorn and Ramaswany 1997); this process contributed greatly to Convergence. First, the industrial share in the developing countries' GDP grew very quickly; second, the working efficiency grew faster than in developed countries.

Thus, due to the shortage of demographic resources, scientific and technological progress supported the move of production from the First World countries to the Third World countries, at the same time making it profitable. The economy of every country is known to comprise different sectors, starting from agriculture. Yet, their hierarchy changes together with the development of innovative spheres within the economy. The less innovative sectors lose their share in economy, while the new ones expand. But within the global economy, due to the international division of labor, the situation is different, and the share of less innovative sectors might even increase. The reason is that the former technologically leading sectors, when leaving the World System core, move to other parts of the World System, not as leaders with the prefix "ex-" but as actual leaders there.[17] First, this occurs in underdeveloped countries via the development of their own production in the ex-leading sectors by means of adopted (imported) technologies. Second, this happens due to the actual transfer of old sectors to the less-developed countries (as has already been mentioned, this process has been going on during the last two or three decades within the process of deindustrialization of the West).

Thus, the structure of the international division of labor, which is generally the World System's most important axis, to a certain extent reflects the historical succession of leading sectors and makes it possible for a new mode of production to emerge in the World System core. But the new wave of technologies requires not only the presence of an innovation cluster but also a "free space" in the leading countries in order to re-orient the workforce. While capital and labor are being reoriented, the old basic commodities should be produced elsewhere in sufficient quantity so that the economy with an emerging new leading sector could have more opportunities, which means, it should get rid of the less-innovative commodities. Otherwise, in the situation of basic commodities shortage, it would be more difficult to concentrate on innovative ones which, despite their importance, becomes less connected with people's basic needs (compare food, clothes, and even metals, on the one hand, with Internet and specific services, on the other). Such a release becomes possible due to the import of goods whose production becomes

[17] The problem of the leading sector has been considered in different aspects in Kuznets (1926, 1930), Rostow (1975), Duijn (1983), Modelski (1987), Modelski and Thompson (1996), Thompson (1990, 2000) and Rasler and Thompson (1994), see also: Rennstich (2002).

unprofitable. Far from everything is logical here; the process of transformation proceeds with difficulty, but the logic of the process contributes to the World System's economic growth and provides opportunities for innovative breakthroughs in different regions of the World System. In fact, this is a way to involve new economies into the operating arena of the new production principle. Even if a number of societies do not fit the principle yet (as at present many countries of the world do not really achieve the appropriate level of the scientific and information production principle), anyway to a certain extent they are getting involved in it (at least in large cities where there already exist some advanced technology centers). Moreover, they become a part of the international division of labor which is formed under the influence of a new principle of production. Therefore, the adaptation of new waves of innovations should be supported by technology and capital transfer to the less developed parts of the World System in order to compensate for the volume and range of commodities not produced anymore in the core.

One of the mechanisms of such shifts within technological modes can be interpreted within the flying geese paradigm which was developed in the late 1930s by the Japanese scientist Kaname Akamatsu [in the early 1960s his works appeared in English (Akamatsu 1961, 1962)]. According to Akamatsu, at first the import substitution of certain goods (e.g. textile goods) proceeds through the establishment of local enterprises, and then the development of the industry contributes to international market entry. However, the role of foreign capital received little attention in Akamatsu's theory, as he worked out his theory proceeding from the observations of the textile industry development in Japan (then still a developing rather than developed country) during the period of 40–50 years starting from the late nineteenth century. The development of Japan between the 1950s and the 1980s, then NICs (Korea, Taiwan, etc.) and later China, Thailand, and Malaysia, in which the role of foreign capital and export sector had already become fundamentally different, allowed many Japanese and foreign scientists to expand and modernize Akamatsu's paradigm. They included the factors of FDI and TNC in their analyses and demonstrated in what way the technological and financial transfers promote economic progress in developing countries (Shinohara 1982; Kojima 2000; Ozawa 1992, 2001, 2005, 2009; see also Ginzburg and Simonazzi 2005; Ito 2001; Korhonen 1998; Kwan 1994; Yamazawa 1990).

> As Ozawa writes: "The countries across the world are at different stages of development, growing at different speeds of structural transformation. This constitutes a basis for dynamic comparative advantages, and the countries within a hierarchy of countries can interact with each other in a complementary and mutually augmenting way so that they can benefit from the 'economies of hierarchical concatenation'" (Ozawa 2001). Such economies are analogous to the effect that a gaggle of 25 flying geese can achieve a "70 per cent-range energy saving over a bird flying solo" thanks to the "wingtip vortex" and "upwash/upcurrent" mutually created by flying together (Gedney 1982). It is also observed in econometric studies on national economic growth that "'regional dummies add substantially to a growth regression's explanatory power (Temple 1999)'" (Ozawa 2010: 5).

The Emergence Within States of a Self-Sustaining System of Motivation for Modernization

The General Idea of Modernization, Development of Forms and the Methods of Its Implementation contributed to the fact that in many developing countries the appeals for reformation and modernization have become extremely important and politically significant. Thus, the governments made certain attempts to somehow promote it. The emergence of Western-educated intellectuals (in particular, via student training in the West and in the USSR) was very important and could be the proponent of the ideas of modernization. As a result, modernization becomes the most powerful political means in a countries' domestic political struggle.

Some Consequences of Changes

Summarizing the abovementioned points, we can say, that the following factors have prepared the ground for the turn toward Convergence: the dramatically increased necessity for the West and the USSR (each for various reasons) to seek alliances with developing countries; the need to put negative processes in the developing countries under control and elaborate proper strategies, scientific ideas, programs etc.*; changes in the Western economies' structure, that required moving industrial production to developing countries; the awakening of the intellectuals and striving for modernization; the role of developing countries as suppliers of raw materials (especially oil) and of cheap—but gradually a more and more qualified—labor force.*

Finally, again we would like to bring our attention to an extremely important point—by the early 1990s, to a large extend due to globalization, most developing countries succeeded in minimizing (if not bridging) the gap with advanced states in terms of human capital development,[18] so that it became possible to move a large number of factories from the core to the periphery of the World System. That, in turn, increased the flow of capital and technologies and thus, launched the process of the Great Convergence. In this respect one can suppose, that the Great Convergence originated from the new wave of globalization, which began in the late 1980s—early 1990s.

Thus, as a result of the above mentioned processes, in the early 1970s the per capita GDP growth of developing countries caught up with the ones in the core of the World System, and since the late 1980s more and more the average GDP growth

[18] In particular, this concerns the education level growth as a factor that increases the necessity for modernization. In the few decades after 1950s most countries of the periphery managed to achieve a sharp increase in literacy (and some other important indicators of the human capital development, see Figs. 4.3 and 4.4), which, on the one hand, stimulated the GDP growth, and, on the other hand, contributed to a very significant decrease of fertility and population growth rates.

of the periphery began to exceed the one of the core. As a result the relative gap between the per capita GDP of the core and periphery began to decrease. The slowdown of economic growth rates in the First World and the acceleration of growth rates in the Third World periphery were accompanied (and to a considerable extent were caused) by the following processes-trends (apart from the above mentioned): (1a) the decrease of the share of investments in the GDP of the core (after the early 1970s); (1b) the increase in the share of investments in the GDP of the periphery (after the early 1990s); (2a) the decrease of the macroeconomic effectiveness of the investments[19] for the First World (after the late 1960s); (2b) the increase in the macroeconomic effectiveness of investment in the Third World (after the early 1990s) (see Figs. 4.1 and 4.2).

As has already been mentioned above, we believe that of special importance is the fact that between 1950 and 1960 and the 1990s we observe a radical decrease of the gap between the "First" and "Third" world with respect to the level of development of the human capital (see Figs. 4.3 and 4.4).

Thus, the Great Convergence is an objective consequence of the world economy development and the result of economic and political development of both

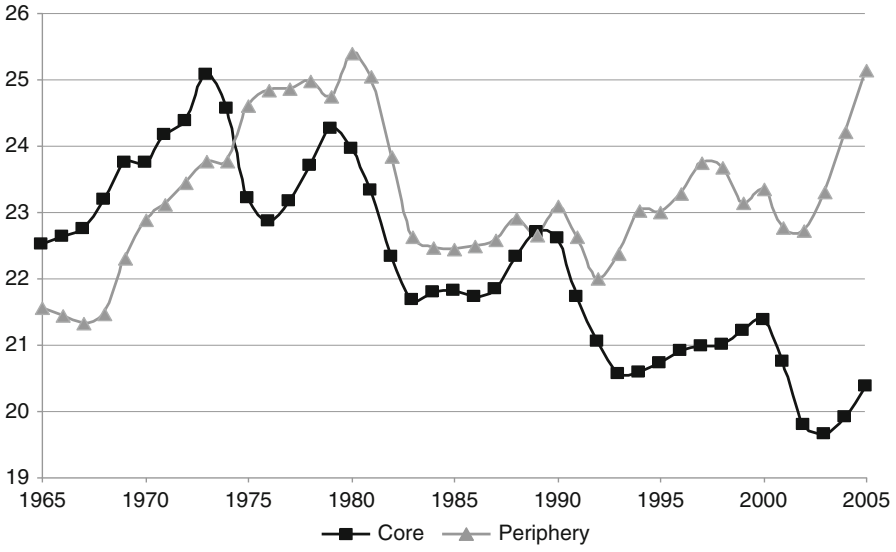

Fig. 4.1 Dynamics of the share of investments in the GDP of the core and periphery, %, 1965–2005. *Source*: Малков et al. (2010: 240, Fig. 6). *Notes*: The World System core was identified for the calculations presented in this diagram with the high-income OECD countries, whereas the World System periphery was identified with the rest of the world. Data source for the calculations: World Bank (2014). Seven-year moving averages (with consecutive decrease of the smoothing window at the edges)

[19] Calculated in dollars of GDP growth per a dollar of investments.

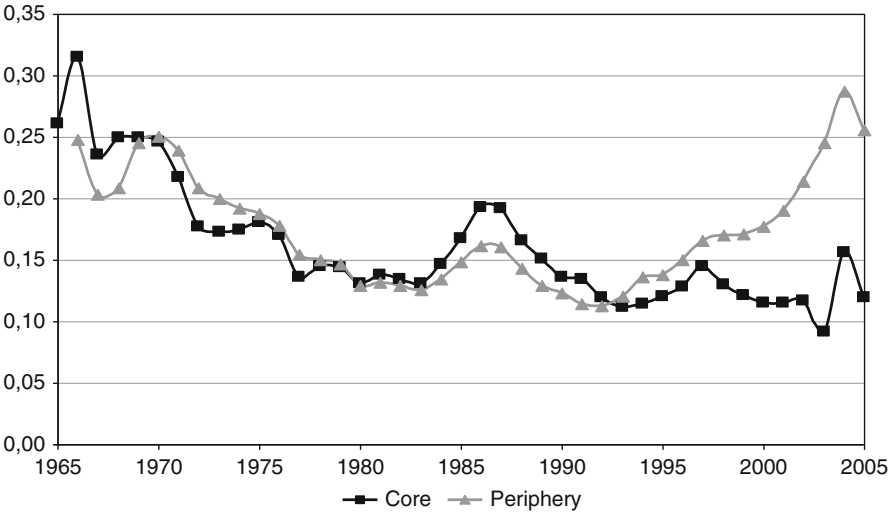

Fig. 4.2 Dynamics of the effectiveness of investments in the GDP of the core and periphery, 1965–2005. *Source*: Malkov et al. (2010: 242, Fig. 8). *Notes*: The World System core was identified for the calculations presented in this diagram with the high-income OECD countries, whereas the World System periphery was identified with the rest of the world. Data source for the calculations: World Bank (2014). Seven-year moving averages (with consecutive decrease of the smoothing window at the edges)

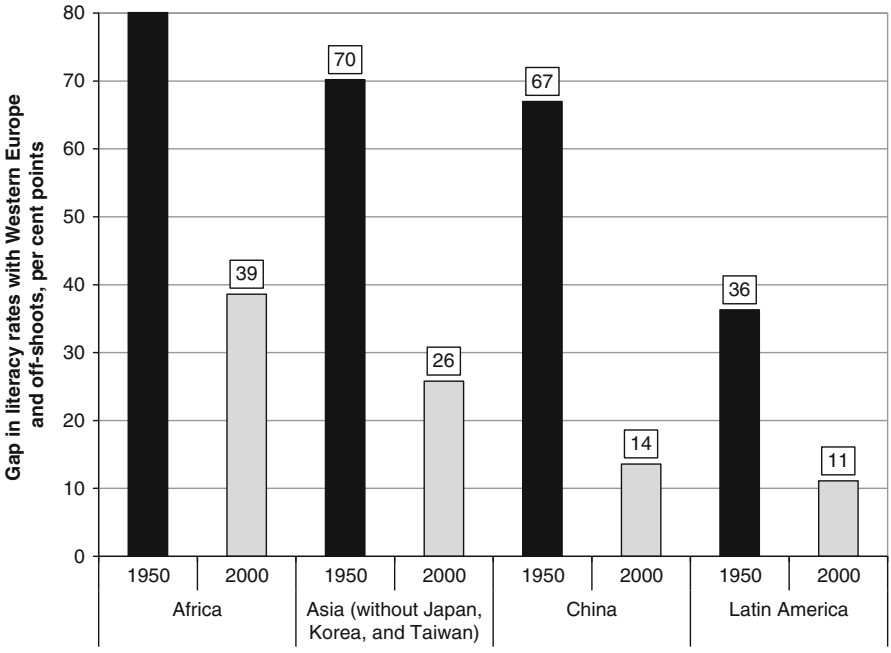

Fig. 4.3 Decrease of the gap between the Western Europe (and off-shoots) and the main Third World macroregions/countries with respect to the literacy rates, per cent points, 1950–2000. *Data source*: Morrison and Murtin (2006)

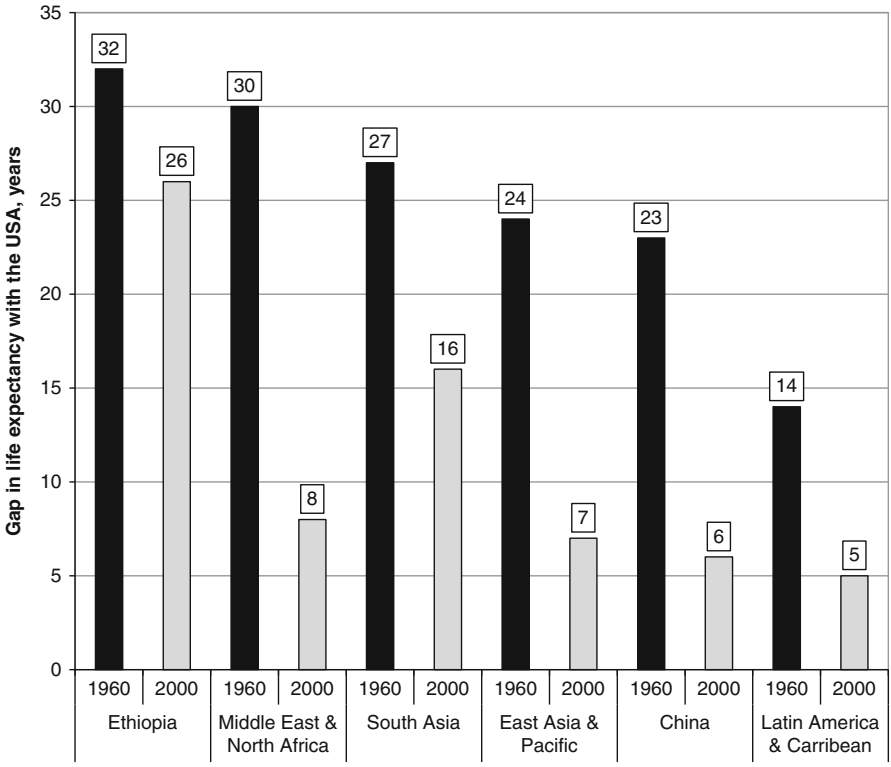

Fig. 4.4 Decrease of the gap between the USA and some Third world regions/countries with respect to the life expectancy, 1960–2000. *Data source*: World Bank (2014)

developed and developing countries (meanwhile, the purposeful or unintentional contribution of the former seems to be even larger than that of the developing states themselves); it is the way to maintain the Western countries' welfare during the demographic crises, and it provides an ability to create a better basis for further innovative development of the world.

In developed countries the increasing welfare of wide populations and the establishment of the middle class as the major layer were the product of a long social and political struggle and of the businessmen's reaction (in terms of technology and organization) to rising wages, demands, and qualification level of personnel. The Great Convergence is also an objective result of world economic dynamics and the interaction result of counteracting development vectors. In the recent decades the middle class has been dissolving in the developed countries (NIC 2012; Grinin 2013). However, this process stimulates the growth of population and the role of the middle class in developing countries, the majority of which is directly involved in production in the Western countries, replacing their domestic specialists.

On Discussions About the Possibility of Convergence: Why Did Economists Overlook It?

The problem of convergence has been one of the critical issues for the economic growth discourse for several decades. This seems most obvious and natural, as one can hardly imagine a more attention-catching question than the following, "Is the gap between the poor and the rich increasing or decreasing?" As has been mentioned above, despite the fundamental changes in Third World economies and societies, for a long time some circumstances (an evident general backwardness of the Third World countries, aggravated by explosive population growth and changes in the leading economies) concealed from the Western economists the fact that the periphery's rate of development had actually surpassed that of the developed ones. To a large extent the beginning of the change was not realized because of conventional ideological stereotypes both in the developed and developing countries. That is why both the conventionalists and advocates of the Western hegemony, as well as radicals considering the latter as the main specific of the established system generating inequality between the core and the periphery and a source of exploitation of the former by the latter, agreed on the presumption that the gap between the developed and developing countries would increase (Prebisch 1959; Sunkel 1966; Wallerstein 1974, 1987; Amin 1976, 1994, 1997; Frank 1979; Bornschier 1976, 1980, 1981, 1982, 1983; Love 1980; Bornschier and Chase-Dunn 1985 etc.).

As a result, the absolute majority of Western economists missed the beginning of the Great Convergence. Most were convinced that the Third World's backwardness was fatal and could only be overcome, if at all (Romer 1986), in the long term after a world socialist revolution (Frank 1979; Wallerstein 1987). Besides, these economists did not comprehend the essence of economic globalization, which presupposes that capital and technologies do not only search for the most profitable areas, but besides, they also contribute to the evening of different regions, developmental levels. However, as we will see below, this process is non-linear, and the law of uneven development acts here in its entirety. In fact, the law of communicating vessels and the law of unevenness combine to make a unified system. In view of the aforesaid, it is worth considering the main subjects of the discussion on divergence and convergence in economic literature.

Accordingly, up to date, the theory of convergence has evolved into quite a number of branches (Islam 2003: 312). Of greatest interest for the present chapter is the essence of the unconditional vs. conditional convergence problem.

The Advantage of the Backwardness According to Gerschenkron and Greater Profits by Investing in Poor Countries After Solow As early as in the early 1950s, the first theoretical works on convergence appeared that revealed possibilities to narrow the gap between the developed and less developed countries through

borrowing off-the-shelf technologies.[20] The cornerstone for the theory of convergence was laid in an essay *Economic Backwardness in Historical Perspective* by Alexander Gerschenkron (1952), who developed the "theory of relative backwardness" relying on data obtained from the history of European countries. The main tenet of his theory is as follows: "the opportunities inherent in industrialization may be said to vary directly with backwardness of the country" (Gerschenkron 1952: 6). Remarkably, Gerschenkron emphasized that the conditions inevitably required for a country to take advantage of its backwardness included "adequate endowments of usable resources' and the absence of 'great blocks to industrialization" (*Ibid.*: 6). Thus, backward countries (provided that the outlined conditions are observed) were bound to grow faster than the developed economies, the former thus gradually converging with the latter.

As Samuelson and Nordhaus put it,

> poorer countries have important advantages that the first pioneers along the path of industrialization did not. Developing nations can now draw upon the capital, skills, and technology of more advanced countries. A hypothesis advanced by Alexander Gerschenkron of Harvard suggests that *relative backwardness* itself may aid development. Countries can buy modern textile machinery, efficient pumps, miracle seeds, chemical fertilizers, and medical supplies. Because they can lean on the technologies of advanced countries, today's developing countries can grow more rapidly… As low-income countries draw upon the more productive technologies of the leaders, we would expect to see *convergence* of countries toward the technological frontier. Convergence occurs when those countries or regions that have initially low incomes tend to grow more rapidly than ones with high incomes (Samuelson and Nordhaus 2005: 584).

The roots of the issue of unconditional convergence are also frequently traced to *A Contribution to the Theory of Economic Growth* by Robert M. Solow (1956). This work is sometimes regarded as the pioneering one in establishing the tenets for the hypothesis of unconditional convergence in economic growth among the world countries (see, e.g., Abel and Bernanke 2005: 235).

As Mankiw notes

> The diminishing returns to capital [implied by the Solow model] have another important implication: Other things equal, it is easier for a country to grow fast if it starts out relatively poor. This effect of initial conditions on subsequent growth is sometimes called the catch-up effect. In poor countries, workers lack even the most rudimentary tools and, as a result, have low productivity. Small amounts of capital investment would substantially raise these workers' productivity. By contrast, workers in rich countries have large amounts of capital with which to work, and this partly explains their high productivity. Yet with the amount of capital per worker already so high, additional capital investment has a relatively small effect

[20] We should note, that the authors considered, first of all, the semi-periphery of the World System core, that is less developed European countries. However, these ideas met the expectation of the newly formed countries for their successful overcoming of backwardness. The situation resembled the one in the formerly (relatively) backward European countries. Due to barrowings of off-the-shelf technologies and techniques and as a result of lower than those in the donor country costs of some production factors (first of all, labor force and minerals) they succeeded to rapidly develop by absorbing investments.

> on productivity. Studies of international data on economic growth confirm this catch-up effect: Controlling for other variables such as the percentage of GDP devoted to investments, poor countries tend to grow at faster rates than rich countries (Mankiw 2008: 258).

Abel and Bernanke also note that according to the Solow model, if the economy is open, the absolute convergence receives the support of some additional economic forces. Since poorer countries have less capital per worker and therefore a higher marginal product of capital than the more affluent countries, investors from richer countries will be able to get greater profits by investing in poor countries. Therefore, foreign investment should provide a more rapid increase in the capital stock in poor countries, even if the level of domestic savings in these countries is low (Abel and Bernanke 2005: 234).

It is easy to see that both the "Gershenkron" factor and the "Solow" factor of the faster growth of the peripheral (and especially semi-peripheral) economies are mutually complementary, as capital diffusion tends to be accompanied by technological diffusion (what is more, capital diffusion is one of the main creators of channels for technological diffusion).

On the other hand, Solow's model implies that the output levels per capita should be higher the higher the savings rate in the country, or the lower the population growth rate. That is why according to this theory, it is the advanced countries' recent leadership in economic development rate over the developing ones that needs explanation. One of the most important explanatory factors of this situation (in addition to the above mentioned low education and qualification level, as well as poor infrastructure of many Third World countries) was insufficient transparency of economic borders, connected to a large extent with various leftist economic experiments starting from the attempts (sometimes successful) of full state regulation of the economy (which minimizes economic transparency) to a seemingly harmless ban on the repatriation of profits (which in fact, in most cases, effectively blocked foreign investments). In this context, the obvious trend of the recent years to level the economic development of the First and Third World countries is a rather logical consequence of expanding real globalization, which would be impossible without increasing economic transparency, and also of the fact that by the 1990s most countries had risen sharply in the level of human capital [especially in terms of education and health (see above for more details)]. The latter, on the one hand, stimulated economic growth and, on the other hand, favored the decline in birth rate and a significant slowdown of population growth rate (that is, this led to the finish of the demographic transition). As a result of all these processes, in recent years we have observed significantly higher growth rates of GDP per capita in most of the countries of the Periphery than in the majority of developed countries, which leads to a logical and rather quick narrowing of the gap between the living standards of developing and developed countries. As the graphs above in Chap. 3 demonstrate, this convergence proceeds much faster than the divergence proceeded in the earlier period.

The Turn to Conditional Convergence Note, that in the 1960s and 1970s no systematic studies of the presence (or absence) of the convergence between the developed and developing countries were undertaken. However, the flood of such studies emerged after 1985.

A counterstrike to Solow's theory of diminishing returns was struck by Paul M. Romer in the mid-1980s, when he published his article "Increasing Returns and Long-Run Growth" (1986), stating that the model of increasing returns offered "an alternative view of long-run prospects for growth" that was contrary to the assumptions of convergence theory: "per capita output can grow without bound, possibly at a rate that is monotonically increasing over time. The rate of investment and the rate of return on capital may increase rather than decrease with increases in the capital stock. The level of per capita output in different countries need not converge; growth may be persistently slower in less developed countries and may even fail to take place at all" (Romer 1986: 1003). Thus, Romer disproved the very essence of the idea of absolute convergence.

This being a starting-point, the second half of the 1980s witnessed the emergence of a wave of works contradicting the idea of absolute convergence and stating the idea of conditional convergence instead (for a detailed literary survey see, e.g., Rassekh 1998). Baumol (1986), for instance, suggested that convergence could be observed within separate groups of countries. Thus, according to Baumol's data, remarkable convergence could be observed among the productivities of industrialized market economies. Convergence was, in Baumol's opinion, shared by planned economies. Less developed countries did not reveal any significant marks of convergence. And, according to Baumol, no absolute convergence could be observed across the world as a whole.

Another substantial work refuting the hypothesis of absolute convergence was the one by Barro (1991). After examining 98 countries in the period 1960–1985, Barro stated that "The hypothesis that poor countries tend to grow faster than rich countries seems to be inconsistent with the cross-country evidence" (Barro 1991: 407).

Another cornerstone of counter-unconditional-convergence discourse was a watershed work by Mankiw et al. (1992). Examining empirically a sample of 98 countries (excluding those where oil production is the dominant industry), they proved the failure of countries to converge in per capita income during the period 1960–1985. However, of greater importance was the introduction of the notion of conditional convergence carried out in their work. After a comprehensive analysis of Solow's theory, the researchers state that the Solow model does not predict unconditional convergence; it predicts only that income per capita in a given country converges to that country's steady-state value, these values being different for various countries. From this assumption Mankiw, Romer, and Weil conclude that "Solow's model predicts convergence only after controlling for the determinants of the steady state", nominating this phenomenon "conditional convergence". The finding of conditional convergence is now considerably well established in the empirical literature, having been regarded in numerous studies on the data of the second half of the twentieth century with different conditioning variables (see, e.g., Caggiano and Leonida 2009; Petrakos and Artelaris 2009; Romero-Avila 2009; Owen et al. 2009; Sadik 2008; Frantzen 2004; de la Fuente 2003; Jones 1997; Caselli et al. 1996; Sala-i-Martin 1996; King and Levine 1993; Levine and Renelt 1992; Barro 1991; De Long and Summers 1991).

At the same time, most researchers agree that there is an obvious convergence among OECD countries.[21] Abramovitz (1986) made a substantial attempt to prove the convergence of productivity levels among the economies of the developed countries. However, Abramovitz made a remarkable comment that the rate of convergence varied from period to period and showed a marked strength only during the first quarter-century following World War II. He also noted that the general process of convergence was also accompanied by dramatic shifts in countries' productivity rankings. His main contribution included extending the simple catch-up hypothesis in order to rationalize the fluctuating strength of the convergence process. The main conclusion made by Abramovitz stated that "differences among countries in productivity levels create a strong potentiality for subsequent convergence of levels, provided that countries have a 'social capability' adequate to absorb more advanced technologies" (Abramovitz 1986: 405). However, the most important remark made by Abramovitz on the basis of his empirical analysis was that "the long-term convergence … is only a tendency that emerges in the average experience of a group of countries", that is, he would not regard convergence as a global-scale phenomenon.

A considerable number of works have been devoted by various scholars to different aspects of convergence in OECD. Initially, there appeared some works that substantially proved the existence of convergence itself across OECD through a systematic catching up in levels of total factor productivity (see, e.g., Dowrick and Nguyen 1989). Later on, the focus shifted to other aspects, such as convergence in aggregate productivity (Bernard and Jones 1996a, b), convergence in international output (Bernard and Durlauf 1995; Caggiano and Leonida 2009), the impact of globalization upon convergence in OECD (Williamson 1996), various sources of convergence (i.e. government size and labor market performance) (de la Fuente 2003), technological diffusion and productivity convergence (Frantzen 2004), stochastic convergence of per capita real output (Romero-Avila 2009), and country size impact upon convergence (Petrakos and Artelaris 2009), etc.

In addition to the above said, one should note that the main conditions of the convergence with the high-income economies were identified, first of all, as (1) a sufficiently high level of development of human capital (comparable with the one of the high-income economies) (e.g., Barro 1991; Mankiw et al. 1992; Cohen 1996); (2) a sufficient degree of economic openness (e.g., Ben-David 1993: 653; Sachs et al. 1995: 199 etc.); (3) a sufficient degree of law and order (e.g., Milanovic 2005; Owen et al. 2009). By the 1990s, all the major developing economies of the world satisfied those conditions much better than they did during the era of divergence.

Currently, there exist a remarkable number of sources revealing the particularities of the convergence process in some regions of the world or in some more groups of countries, such as Latin America (e.g., Dobson and Ramlogan 2002; Galvao Jr.

[21] In our opinion, such convergence evidenced for a significant extension of the World System core that, according to the world-system theory, was to indicate the transition of the role of the semi-periphery the countries of the former periphery, that is to the developing countries. In other words, the Third World countries were to approximate to those of the First World. Thus, convergence in the Western countries implied inevitable convergence within the whole World System.

and Reis Gomes 2007 etc.; see also Красильщиков 2011), ASEAN (e.g., Lim and McAleer 2004), some particular Asian regions and countries (Li and Xu 2007; Zhang 2003; see also the flying geese paradigm above), and transition countries (e.g., Rapacki and Prochniak 2009).

Factors of Conditional Convergence Various researchers tried to specify the factors underlying the process of convergence (or its failure). Thus, Abramovitz emphasized the importance of education and organization for the process of convergence. With respect to the convergence factors, Abramovitz (1986: 405) stated that "the pace of realization of a potential for catch-up depends on a number of other conditions that govern the diffusion of knowledge, the mobility of resources and the rate of investment".

The suggested failure of unconditional convergence was attributed to different factors by various students. Thus, Bradford De Long (1988: 1148) assumed that one of the factors driving some countries towards convergence was technology becoming a public good.

Barro (1991: 437) concluded that "the relatively weak growth performances of countries in sub-Saharan Africa and Latin America" and their failure to catch up with the developed countries (i.e. the absence of absolute convergence) could be attributed to the lack of human capital development, discovering the fact that in his data set of 98 countries in the period 1960–1985 the growth rate of real per capita GDP was positively related to initial human capital.

Cohen (1996: 351) stated that "the poor countries have failed to catch up with rich ones because the progress that they have achieved in educating their workers (which is evidenced in the convergence of domestic inputs) is not sufficient to compensate for their poor endowment in the knowledge on which the education of workers stands". Sadik (2008) explained that simultaneous convergence among industrialized countries could be caused by the fact that technological progress diminishes the differences within the group of countries that adopt technologies but increases the gap between those countries and the rest of the world.

Milanovic (2005) devoted his study purely to specifying the reasons for catch-up failure, listing the following causes: war and civil strife, and a delay in reforms among the least developed countries (LDC). Direct foreign investment and democracy, according to Milanovic, did not have any significant influence upon the failure of catch-up process among LDC. Yifu Lin (2003), on the other hand, supports the idea that the failure of most LDCs to converge with developed countries in terms of economic performance can be explained largely by their governments' inappropriate development strategies.

Owen, Videras, and Davis, observing countries growth experiences over the 1970–2000 period, found evidence that "the quality of institutions and specifically, the degree of law and order, helps to sort countries into different regimes" (regimes being here quite synonymic to the notion of convergence clubs) (Owen et al. 2009: 265).

Sachs et al. revealed the connection between convergence and economic openness and international trade, stating that "the absence of overall convergence in the world

economy during the past few decades might well result from the closed trading regimes of most of the poorer countries" (Sachs et al. 1995: 37). They present an evidence suggesting that the lack of convergence observed across the world can be "explained by the trade regime: open economies tend to converge, but closed economies do not. The lack of convergence in recent decades results from the fact that the poorer countries have been closed to the world" (*Ibid.*: 3).[22]

Some Results of Convergence Research In general, the main results of the two decades of the unconditional convergence research seem to be summed by such statements as follows:

> Empirical studies have shown consistent evidence of a cross-country income distribution displaying bimodality with a marked thinning in the middle. This result is interpreted as showing that poor countries are not catching up with the rich, but rather that there is evidence of club convergence, that is, polarization at the extremes of the income distribution (Cetorelli 2002: 30).

> Unfortunately (from the perspective of the world's poor countries), there is little empirical support for unconditional convergence. Most studies have uncovered little tendency for poor countries to catch up with rich ones (Abel and Bernanke 2005: 235).

> There is no evidence of (unconditional) convergence in the world income distribution over the postwar era (Acemoglu 2009: 17).

Besides, Acemoglu adds at this point:

> Combining the postwar patterns with the origins of income differences over the past several centuries suggests that we should look for models that can simultaneously account for long periods of significant growth differences and for a distribution of world income that ultimately becomes stationary, though with large differences across countries. The latter is particularly challenging in view of the nature of the global economy today, which allows for the free flow of technologies and large flows of money and commodities across borders. We therefore need to understand how the poor economies fell behind and what prevents them today from adopting and imitating the technologies and the organizations (and importing the capital) of richer nations (Acemoglu 2009: 22).

However, does the paradox outlined by Acemoglu actually exist? Does not really "the global economy today, which allows for the free flow of technologies and large flows of money and commodities across borders" lead to its logical outcome—the general convergence? Are poor economies of the world still generally failing to "adopt and imitate the technologies and the organizations (and import the capital) of richer nations"? We suppose that unfortunately, economists did miss the turn to the Great Convergence. Having pointed that convergence in the World System core expanded, they did not realize that was the indicator of the general convergence

[22] Sachs and Warner might not be entirely satisfied yet with the degree of economic openness of, say, Russia, China, or Ethiopia. But they would hardly argue against the point that Chinese and Russian economies are *radically* more open now than they used to be in the 1960s, whereas the Ethiopian economy is radically more open now than it used to be in the late 1970s. On the other hand, the evidence that we present suggests that Sachs et al. (1995) appear to have exaggerated the degree of economic openness that is necessary for the convergence phenomenon to develop.

process. Having emphasized unevenness of convergence, they left aside that convergence proceeds in a wavelike manner, that upsurge of some developing countries inevitably contributes to a rapid progress of their new group. In any case, we suppose that the switch from the conditional to unconditional convergence pattern seems to be accounted for by the point that by the 1990s all the major countries and economies of the world began to satisfy (more or less) the major criteria for the conditional convergence.

Globalization Becomes the Major Cause of Convergence

Today globalization is one of the most popular trends of scientific research that seems to be rather reasonable and perspective.

Globalization is a result of a very complicated alloy of political, social, economic, civilizational and many other processes of the modern world (see, e.g., Modelski et al. 2008; Eisenstadt 2010; Etzioni 2011). However, among these numerous factors one should especially mark out the huge changes in modern productive forces, technologies, media, world trade and specialization (Медведев 2004: 3; Гринин 1999, 2005, 2007). Thus, the directions, forms and results of the processes will constantly depend on the changing balance of the world forces, on the strategy that will be chosen by these or those countries and associations, on different geopolitical factors and so on. In our opinion, it means that those who are longing to play a more important role in integrating and changing the world must forecast and foresee the tendencies that can be used for benefit (about the available possibilities for different countries and particularities of national paths in globalization see Harris 2003: 65; Srinivas 2002; Talavera 2002; Yan 2002; Berger 1986, 2002; Grinin 2012a).

But what is globalization after all? There does not exist a generally accepted definition and presumably it will not appear in the immediate future, as far as it has most diverse meanings (for some interpretations of globalization see, e.g., Albrow and King 1990; Scott 1997; Holton 1998; Bayliss and Smith 2001; Eisenstadt 2010; Kiss 2010; Gay 2010; concerning the formal measuring of globalization see Dreher et al. 2010). Without any claim to an unequivocal definition, we would determine it in the following way. *Globalization is a process by which the parts, countries, peoples* etc. *of the world become more connected and more dependent on each other. Both the increase in the quantity of problems common for states and the expansion of the number and types of globalization's subjects take place.*[23]

In other words, there emerges a peculiar system where the problems of separate countries, nations, regions and other subjects (corporations, different associations, global media holding companies etc.) interlace into one tangle. Separate local

[23] In the present chapter we do not purport to give a detailed review of the works on globalization and different views on this process (on diverse definitions of globalization see, e.g., Al-Rodhan 2006; for our ideas in detail see Grinin and Korotayev 2010a, 2012c, 2014; Sheffield et al. 2013; Гринин and Коротаев 2009в; Grinin 2012c).

events and conflicts affect a great number of countries. At the same time decisions in the most significant centers of the world have an effect on all the fates. In general the processes of globalization in the broadest sense are characterized by the abrupt intensification and complication of mutual contacts in the basic spheres of economic, political and social life, gaining planetary scales (Иванов 2004: 19). Globalization is an exclusively versatile process. Practically all spheres of life experience its impact (see, e.g., Гидденс 2004). Lots of positive as well as negative phenomena also gain a global character, e.g., the struggle for the preservation of environment, human rights (Sapkota 2011; Taran 2011; Collins 2010), the antiglobalist movement itself (see, e.g., Gay 2010; Yanling 2010; see also Tomlinson 1991; Kinnvall 2004), terrorism and crime (see, e.g., Мирский 2004б: 80; Лунеев 2005: 114–115; Glenny 2008), drug mafia (Glenny 2008) etc. In this respect the idea of globalizing Islam and other religions is of great interest (Roy 2004; Мирский 2004a: 35; see also: Schaebler and Stenberg 2004; Abushouk 2006; Eisenstadt 2010; Robertson 2011).

Great Convergence, Globalization, and the Decline of the Leadership of the USA and the West The discussions of an inevitable eclipse of the American might have begun already in the 1970s when this country confronted simultaneously political, economic, and currency crises. In the 1970s and the 1980s a number of forecasts predicted that the USA would be replaced by Japan in the role of the world economic leader (see, e.g., Vogel 1979; Kennedy 1987; Attali 1991). There were a lot of works analyzing new challenges to the USA connected with the defeat in Vietnam, monetary and oil crises, fall of the USA share in the world economy etc. (see, e.g., Stohl and Targ 1982; Rosenau and Holsti 1983). However, a new vigorous technological wave in the USA (that took place against the background of the economic stagnation in Japan) demonstrated the fallacy of such views. The US hegemony did not only turn out to be rather solid; what is more, it rose to a new level as a result of disintegration of the Communist block and the USSR.

However, these were just the 1990s when the number of forecasts predicting the inevitable decline of the American hegemony and the ascent of Asia to the leadership positions started growing rather rapidly (see, e.g., Thompson 1988; Attali 1991; Colson and Eckerd 1991; Frank 1998; Todd 2003; Wallerstein 1987, 2003; Kupchan 2002). First such forecasts were taken rather skeptically, or were received as a sort of expression of leftist views and anti-American moods. However, with the growth of negative tendencies in the USA and successes of Asian countries the idea of the American decline started looking more and more grounded, which provoked (depending on one's orientation) feelings of triumph or apprehension. Nowadays, taking into account the consequences of the global crises, the forecasts of the decline of the US role in the world appear to be shared by the overwhelming majority of analysts. The USA and American people seems to have started putting up with the idea of the decline of the American hegemony—though many still seem to pin their

hopes on some sort of technological or other miracle that will revive the American might (this is often expressed rather vividly in President Obama's speeches).

Thus, there is no much doubt that the USA hegemony (which has continued for more than 60 years) is coming to its end. Sooner or later the USA will not be able to remain the World System leader in the sense that has become usual for us, as a result of which the global geopolitical landscape will change rather seriously (see, e.g., Grinin and Korotayev 2010b, 2011; Grinin 2010, 2011b, 2012b, c; Grinin et al. 2015; Гринин 2012). On the other hand, hopes of some political scientists and economists that a sort of total collapse of the USA will take place very soon (e.g., Айвазов 2012) appear rather ungrounded; the relative decline of the USA will proceed gradually (and not without certain interruptions), while certain objective circumstances (including the rise of peripheral countries) will contribute to this. However, in the forthcoming two or three decades the USA will remain a sort of *primus inter pares* because of their superiority with respect to a few aspects of leadership and a certain "legality" of its leadership role (NIC 2012: XI). In addition, one should take into account that, on the one hand, the USA is not going to surrender the leading position to anyone using all possible legal and illegal means to hold it and to weaken rivals, and on the other hand, the world as a whole is still interested in America's enduring leadership.

Some Causes of the Weakening of the USA (and the West in General) Since the end of the Second World War one could see in the world a rather unique situation when one country—the USA—became the world hegemon in so many respects: political, military, monetary, economic, ideological, technological, cultural, educational, artistic, innovations, and so on. For a rather long period of time this leadership was strengthened by the competition with the world Communism, which unified the West and stimulated a vigorous energy in the United States (Devezas et al. 2007). After the collapse of the USSR the USA became the absolute hegemon of the world. And this may appear paradoxical, but it was the obtaining of the status of the absolute hegemon that contributed to the start of the eclipse of the US might. On the one hand, this weakened the country's readiness to sacrifice anything (as it was done within the context of the Cold War); on the other hand, against the background of the apparent omnipotence, the American leaders chose a generally wrong strategy trying to transform internal American tasks into goals of the US foreign policy (Kissinger 2001). As a result, within two decades the US administrations made and keeps making many mistakes. Through their various actions they dissipated a certain safety factor that the US had, shook their own might, accumulated exorbitant debts, and created a detonator for the global crisis whose consequences are not clear yet. In the meantime, within less than two decades, between 1991 and 2008, against the background of the weakening of Europe and continuing stagnation of Japan one could see the explosive growth of the Asian giants (China and India) as well as the formation of large group of fast developing countries (from Mexico to Malaysia) that will take leading positions in the world in foreseeable

future (this is, of course, very tightly connected with the process of the Great Convergence that has been discussed above).

How did this take place? And (what is the most important) why? Quite a number of explanations have been suggested by now. For example, "Decline of the West" may be interpreted in spirit of Oswald Spengler (1918) or Pat Buchanan (2002), that is from the point of view of the theory of civilizations and the renunciation of moral imperatives.[24] However, this, of course, fails to account scientifically for the actual causes of the "moral degradation". The weakening of the USA may be also regarded as the confirmation of various theories of cycles of political hegemony (e.g., Modelski 1987; Thompson 1988; Modelski and Thompson 1996; Arrighi 1994), according to which the hegemony period lasts about 100–200 years, whereas afterwards an old hegemon tends to be replaced by a new one. Indeed, no country can remain a global hegemon infinitely. However, the point is that the forthcoming change of the global hegemony pattern will not mean just a "usual" replacement of the USA by a similar absolute world leader.[25] And if there is no single absolute leader, the world will be structured in a significantly different way (see, e.g., Grinin 2010, 2012a; Grinin and Korotayev 2010b, 2011). Thus, with the eclipse of the USA the cycles of political hegemony are likely to come to their end. We will return to this point in the concluding chapter.

It is rather natural to consider the change of geopolitical landscape as a result of mistakes and arrogance that become typical for great powers at a certain phase. Jawaharlal Nehru notes in this respect that history of great powers goes through three stages: success, the consequence of success—arrogance and injustice, and as a result of this—fall (Nehru 1949). Indeed, a very considerable number of mistakes (including rather evident ones) have been made. One may even have an impression that Western democracies tend to lose their very important quality—to make correct conclusions from their own mistakes. Some evidence in support of this statement appears to be suggested by a sort of maniac attempts to topple regimes in the Middle East and East Europe without a sufficient care for consequences, without taking into account experience of their involvement in Lebanon, Palestine, Somalia, Afghanistan, Iraq, Libya, Syria…

However, those very mistakes (as well as changes in behavioral patterns of elites and commoners) may be regarded as results of deeper processes. Hence, it is very important to see those processes that change the world (often contrary to the will of those who seem to be in the center of the events).

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[24] "The de-Christinization of America is a great gamble, a roll of the dice, with our civilization as the stakes. America has thrown overboard the moral compass by which the republic steered for 200 years, and now it sails by dead reckoning" (Buchanan 2002: 198).

[25] Note that William R. Thompson was one of the first to arrive at this conclusion—while analyzing possible challengers to the USA leading position in the 1980s he demonstrated that at that time the USSR was the only state that could compete with the USA militarily, whereas Japan was the only state that could compete with the USA economically—while there was no state that could take all the World System hegemony functions of the USA (Thompson 1988: 261–282).

Is the Globalization the Main Cause? As we could see above, if we consider the situation in retrospective, the decline of the might of the USA and the West was inevitable. The crisis of 2008–2014 just revealed in a rather distinct way the trend that had become rather pronounced well before the crisis, the trend toward the weakening of the main Western economic centers and the inevitability of the loss of the absolute hegemony by the West. We are dealing here with a certain historical logic that, however, has not been completely comprehended yet: *the development of globalization after it had reached its certain phase became incompatible with the well-established model of the American and Western hegemony.* Thus, the very globalization (that was actively imposed by the USA; that is stigmatized by the antiglobalists of all the countries; that is often regarded as the main source of problems for the developing countries) made the trend toward the relative weakening of the rich countries and the relative strengthening of the poor countries inevitable. Consider this point in more detail.

How the Globalization Have Weakened the Core and Strengthened the Periphery

We have already mentioned the law of communicating vessels above. Now let us dwell on it.

Law of Communicating Vessels of the World Economy As we could see above, up to the early 1970s the development of globalization was accompanied by the increasing gap between the rich and poor countries with respect to a number of important characteristics, especially, if we compare their GDP per capita levels. At the same time much was done to prepare the start of convergence. Then, in the recent decades, some world economic processes, particularly globalization, began to contribute more and more to the closing of this gap. "The developing world's share of global employment and global exports rose steeply, initially on the basis of manufacturing experience plus low wages and economies of scale. Employment and export shares both increased from the 1970s to the 1990s by at least 10 % points" (Amsden 2004: 256).

Thus, it appears possible to speak about the "*divergent globalization*" (approximately up to the 1970s) and the "*convergent globalization*" (since the 1980s). However, it appears important to note that a rather pronounced convergence between the First and the Third World was already observed in the 1990s; however, this convergence can be hardly seen when "the West" is compared with "the Rest", as in this case the convergence between the First and the Third World was obscured by a catastrophic economic decline observed in the early 1990s in the Second World (see Chap. 3).

Hence, the very essence of the last globalization wave implies that the developing countries must grow faster than the developed.[26] This is because the globalization increases the transparency of economic borders and this brings into action what may be called the "law of communicating vessels". As a result the development of periphery (and, especially, semiperiphery) accelerated, whereas the growth of the countries of the World System core slowed down. There is no doubt that this is one of the main results of the global development in the last two decades.

According to the World Bank, just 20 years ago the share of the most developed countries (=the First World = "the West"[27]) in the world GDP (calculated in the constant 2005 international purchasing power parity) was almost twice as high as the one of the rest of the world. It started declining in the 1990s, but these were the 2000s when this decline became precipitous, and by now the share of the Rest already exceeds the one of the West (see Chap. 3).

Law of Communicating Vessels of the World Economy and Awakening of Masses Many economists of the 1960s and the 1970s did not have much hope that in the forthcoming future there would be much chance to bring the countries of the global South from the obscurity of backwardness. They were right to consider as the main obstacle the absence of the aspirations to improve their lives among the population of those countries. Poverty did not bother people, they did not perceive it as an unbearable state that should be escaped as soon as possible [on this see, e.g., the book by Noble Prize Winner Gunnar Myrdal (1968; see also his earlier work Myrdal 1956); the same opinion may be also found in the famous book of Braudel (1973)]. Such a psychology, which was described by economists in the 1950s, 1960s, and

[26] This especially relevant for those developing countries that passed a certain threshold level of per capita GDP, which has been identified by Ho (2006) to be around $1,150 [note that this is rather congruent with the "take-off" theory of W. W. Rostow (1960)]. The growth of the convergence rate in the recent decades is directly connected with the fact that during those decades one could observe a very significant growth of the number of those developing countries that passed that passed this threshold level. Indeed, as we have argued on a number of occasions these are medium developed countries that tend to grow faster than either the least developed countries or the most developed ones (see, e.g., Коротаев and Халтурина 2009; Korotayev and Zinkina 2014; see also *Statistical addendum to* Chap. 3). It is also very important to stress that at present the majority of the developing countries (with a total population of about five billion) belong to the category of the medium developed ("middle income") countries (World Bank 2014), whereas only the minority of the Third World population [the so-called "bottom billion" (Collier 2007)] live now in the least developed countries. Note also that in the recent years the least developed countries tend to grow faster than the most developed ones, but still slower than the medium developed states (see Korotayev and Zinkina 2014 and *Statistical addendum to* Chap. 3).

[27] Here this notion is operationalized as "High Income OECD Countries" according to the World Bank classification.

1970s (see above), may still be found among some inhabitants of the most underdeveloped areas [especially, in Tropical Africa (see, Allen 2011)].[28]

However, in many developing (mostly middle-income) countries the situation has changed, that is why the Third World is transforming from sleeping and apathetic into rather dynamic indeed (see, e.g. Korotayev et al. 2011a, b, 2012; Korotayev and Zinkina 2014; Grinin 2013). And one of the main changes may be seen just in the change of life priorities of hundreds million, who make more and more active attempts in order to escape from poverty and illiteracy into a new life.

Thus, the most difficult precondition for the breakthrough turns out to awaken this activity in the population of the poor countries (this requires very considerable efforts aimed at the initial modernization of education and health care, that is the initial accumulation of the human capital). However, when the need to enhance the conditions of life emerges at the mass scale, this puts into work a powerful motor. This may produce a qualitative result (though such a "Brownian motion" is almost always connected with various sorts of lawlessness, injustice and so on). When it starts, the movement toward the change of people's own life to the better tends to generate social energy for many decades. And when we observe a synergy of efforts produced by the population and by the state, the success may be overwhelming. This is what happened in China, India and many other developing countries (Grinin 2011b, 2013; Grinin et al. 2015).

In rich countries (notwithstanding all their achievements in culture and education) this source of development has already dried up. Motivation toward hard work does not decrease only among some groups of immigrants struggling for their (and their children's) economic status (and, by the way, in the USA this supports the economic dynamism up to a considerable extent).

And taking into consideration the population aging, possibilities for fast development are further shrinking more and more. It appears important to emphasize that *among the causes of the weakening of the relative might of the West an important place belongs to the dramatic slow-down of the population growth rates in the West (whereas in some developed countries those growth rates have even become negative) which is accompanied by its very significant aging* (see, e.g., Goldstone 2010; Powell and Khan 2013). This leads to the decline of the working age populations and explosive growth of the number of pensioners.[29] In the meantime it was the

[28] Note that even in the 1990s some very important economists (like Jacque Attali who was the President of the European Bank of Reconstruction and Development at that time) still believed that the overwhelming supremacy of the global North over the global South would only increase in the forthcoming decades and would continue in the foreseeable future. Attali, for example, was sure that in the forthcoming decades many markets of the North would become closed for imports from the impoverished South. He expected the desperate popular masses of the World System periphery to continue observing in painful despair the efflorescence and richness of the World System core (Attali 1991).

[29] Note that the USA has certain advantages here as regards higher fertility and immigration rates, which are among the main factors making the US economy more dynamic than the European economies.

globalization that increased dramatically the demand for the main resource of poor countries—their workforce. What is more, the value of this resource is likely to continue growing further in the forthcoming decades (see, e.g., Grinin 2011b, 2013; Zinkina and Korotayev 2014; Grinin and Korotayev 2010b, 2014) though for many developing countries in South Asia and, especially, Sub-Saharan Africa this will still be an extremely difficult task to find a productive employment for hundreds million young working hands (Zinkina and Korotayev 2014).

As has already been mentioned above, the openness of economic borders creates a situation when a sort of law of communicating vessels of the world economy begins to act; whereas the above described arrangement of labor incentives and labor resources determine to a considerable extent the work of this system of communicating vessels. In order to make the production cheaper, capitals and production capacities of the developed countries are transferred to the developing countries where one can find hundreds million young women and men looking for a job. Together with this, the motor of the world economic growth is also transferred from the core to the periphery (which implies a significant reconfiguration of the World System). As a result, the role of the developing countries in the world economy (especially, as regards the generation of its growth) is increasing, whereas the gap between them and the developed countries is decreasing (though is still remains very significant).

Thus, by now the globalization of recent decades has worked mostly in favor of developing countries notwithstanding claims that it only increases the gap between the developed and developing countries (see, e.g., Stiglitz 2002). In spite of many just observations made by the critics of globalization, we should maintain that it is Jagdish Bhagwati (2007) who turned out to be right with his vigorous defense of globalization (see also Amsden 2004). And we do not see sufficiently strong factors that can stop entirely the Great Convergence rather than just to slow it down.[30]

And could it be the other way? It is not rare when a logic of a certain process remains unclear and contradictory for a long period of time; the attention is attracted by those very features that disappear later, whereas the most important characteristics remain some time blurred. It becomes clear only later that the process was bound to acquire those characteristics. This was what happened with globalization. Let us consider if the development of globalization had substantial chances to bring significantly different results.

For a rather long period of time (as we have seen above) the expansion and intensification of the economic links in the world proceeded (up to a considerable extent) through the transformation of peripheral economies into agrarian and raw material

[30] A certain slowdown is not entirely unlikely against the background of possible successes in the "reindustrialization of the West" and industrial application of robotics.

sources for the developed states.[31] As has been mentioned above, that is the reason why many development students (e.g., Frank 1979; Wallerstein 1974, 1980, 1988, 1987, 2003; Amin 1976, 1994, 1997) believed that the world-system core (≈the West) could only exist through the exploitation of the periphery, through its imposition on the developing countries of such an economic specialization that would preserve the leadership of the developed countries. It was also rather comfortable ideologically to equate the new globalization wave with a sort of modernized neocolonialism, maintaining that it either conserves the global inequality, or will even increase the gap between the developed and developing countries. There seem to have been certain grounds for such believes. However, finally the logic of the globalization process has turned out to be rather different. Why? The point is that that the globalization does not only increase the number of economic ties, it also extends enormously the world economic space. And this means a constant transformation of the international division of labor, which in the developing countries, as we have seen above, was transformed from colonial to more advanced Actually this could have only happened in the following way—while advanced countries concentrated on the development of new sectors, the technologies of older generations must have been transferred to less developed countries (Гринин 2013; Grinin and Korotayev 2014; see also Amsden 2004). One should also take into account the exhaustion of labor resources in the developed countries, and the abundance of such resources in the Third World. Thus, globalization objectively forced those countries that developed postindustrial economy and that could hardly support all the economic sectors to move industrial production to weakly industrialized regions.[32] As a result of such a diffusion (greatly facilitated by the opening of international borders for the movement of capitals and the growth of the human capital development level in the Third World) one can observe a transfer of a substantial part of the World System core

[31] However, even such a development was rather important for the modernization of the peripheral countries. Note also that in the nineteenth century ones of the most salient examples of transformation of whole colonies into agrarian and raw material sources for the developed states were represented by Australia, Canada and New Zealand. However, by 1913 the average level of life in Canada [estimated through the per capita GDP level, which, in 1913 in Canada, according to Maddison (2010), was equal to 4,447 international dollars (to be exact—1990 Geary—Khamis international purchasing power parity {PPP} dollars)] was considerably higher than the Western European average ($3,687), whereas in Australia and New Zealand ($5,157 and $5,152 respectively) it was higher than in the most prosperous Western European countries of that time. Note that now Australia is still a major agrarian and raw material source, though in the present-day for China rather than Western Europe. In the meantime the average level of life/per capita GDP in Australia [$34,396 (2005 PPP dollars)] is till now a few times higher than in the workshop of the present-day world, China.

[32] Such processes contributed to the economic development in the nineteenth century too, though the transfer of industrial production was not so wide-spread. However, in the nineteenth century one may note similar processes with respect to the agricultural production. In this century, as a result of explosive urbanization, the share of agriculture in the Western European GDP declined, whereas the demand for food increased dramatically. This led to the fast development of market-oriented agriculture (and economy in general) in many peripheral areas (Australia, Russia, parts of India, Argentina, the American West). Of course, the results in India dramatically differed from the ones in, say, Australia. Why? We have tried to answer this question in Appendix B.

industries to the World System periphery. On the other hand, many developing countries have applied a lot of efforts of their own to achieve their industrialization.

Causes of the Change of Economic Balance of Forces in the World Now summarize the points indicating that the convergence was a virtually inevitable result of the globalization process.

1. *Development of new technologies led to the situation when the technologies of older generations became cheaper and cheaper.* The transition of the Western economies to new technologies connected with the production of highly skilled services [in conditions of scarcity and high costs of their labor (as well as high ecological standards)] demanded the transfer of the old industries to the periphery. The transfer of those industries led to the rise of the peripheral countries (see, e.g., Grinin 2013).

   The so-called financial revolution and the encouragement of the migration of capital between countries had a significant influence on the developing states' advance.[33] Capital (whose volume steadily grew) searched for more profitable investments and often found them in young economies. Thus, the countries that actively attracted capital and created favorable conditions for it would benefit. At the same time, we could also observe some important negative consequences of this situation which led to a number of crises (in 1997 etc.) and improved the control (although partial) of foreign capital activity. One can agree with Amsden (2004: 253) that "the debt crisis in Latin America in 1982 and in East Asia in 1997 were both preceded by a *surge in investment*". Anyway, the direct investments in developing economies in the 1990s and 2000s appeared the major channel to attract long-term private capital, new technologies and managerial experience which often appear to have been more effective than local enterprises (Руденко 2006: 7). The following figures evidence for the private investment growth rate: in 1990, the net inflows of investment to developing countries was 35 billion dollars and in 1994–1996 they already constituted 200 billion dollars a year (Ibid.: 6). Of course, the foreign investments spread unevenly in different Third World regions and countries (to a large extent that depended on effectiveness of the states' economic policy and other factors).[34]
2. *For the functioning of the transferred industries it was necessary to raise the level of the recipient countries in many respects.* Developing countries became production grounds (assemblage workshops, preliminary procession industries, etc.).

[33] Hernando De Soto argued that "the major stumbling block that keeps the rest of the world from benefiting from capitalism is its inability to produce capital" (de Soto 2000: 5). So with the financial revolution and deindustrialization the strength of such a "stumbling block" declines significantly.

[34] In this respect, the Arab states in the 1990s serve an example of low-active and ineffective policy. For example, while the investment inflow to developing countries in 1990 and 1996 generally increased six times, in the Arab countries it was far from increasing, on the contrary it only halved (Руденко 2006: 6), yet in the 2000s the effectiveness of those policies increased in the Arab countries very significantly (see, e.g., Korotayev and Zinkina 2011).

However, such production grounds could only function in the presence of minimal required infrastructure, financial sector, a certain qualification of workers (implying the elimination of illiteracy and some development of secondary and higher education) and so on. The West blamed 'Third World peoples for their lack of entrepreneurial spirit or market orientation' (De Soto 2000: 4) and insisted that the developing countries should develop all these.

3. *The transfer of industries launched a vigorous source of growth.* In a number of poor countries it set in motion two of their very important advantages: vast labor resources and their cheapness. As a result they did not only start producing cheap goods in great quantities—industrialization and modernization greatly accelerated in those countries. And those processes for decades (due to the rural–urban migrations) generate a rather fast economic growth.
4. *These were the unshakable globalization principles that led the West to its deindustrialization* [including, in particular, the so called Washington Consensus (see, e.g., Korotayev 2010); see also de Soto 1989]. The very globalization principles (free trade as well as free movement of capitals) have made the process of the production transfer to those regions inevitable (see, e.g., Grinin 2013).
5. *The West and Japan themselves gave modernization technologies to developing countries*. In order to preserve their leading positions, the Western countries actively taught the developing countries what they should do, insisted on the acceleration of their modernization; what is more, they developed strategies of such a modernization; and, through the system of international development centers, they provided them with significant help in this regard. In many countries this coincided with desires and efforts of local elites; and in many cases this resulted in impressive successes of respective countries. Success of Japan (and later "Asian Tigers") created an effective model of catch-up development based on the fast development of the exporting sectors, and this model started diffusing (see, e.g., Grinin 2011b; see also above about the "flying-geese" paradigm).
6. *Cheap industrial products defeated the industry of the West.* The expansion of the importation of cheap manufactured products to the Western countries made the process of the transfer of industries to the poor countries irrepressible. Western producers failed to compete with low prices and were not ready to pay more to support their industry.

Who Have Found Themselves in the "Globalization Trap"? So the transfer of industries to the developing countries created such conditions when they started growing faster than developed states. This is hardly surprising taking into consideration the point that for a few decades industrial capacities and capitals were leaving developed countries while entering the developing ones. In addition, this was supported by active policies of the developing countries' elites who tended to actively attract investments and technologies to their countries, to eliminate barriers in their ways.

Compare, for example, economic growth of Mexico and the USA. The transfer of industries from the latter to the former [that especially accelerated after the establishment of the North American Free Trade Area (NAFTA) in 1994] has led to the

following results: between 1986 and 2012 the Mexican GDP grew nine times (from $129.4 billion to $1153.3 billion); the GDP of Brazil (that also actively imported capitals and technologies) grew comparably—eight times and a half, whereas the USA GDP only grew 3.4 times (respectively from $4,425 billion to 14,991 billion).

In the meantime the Mexican and Brazilian economies are far from being the fastest growing (and in the 1980s and the 1990s their economic and financial systems experienced serious turbulences). In the same years Malaysia and Indonesia increased their GDP about 11 times. Since 1991 (that is, since the country's economy had become open to the importation of foreign capitals) India increased its GDP 7 times just within 20 years (whereas between 1980 and 2012 it grew about 10 times). And, finally, China between 1986 and 2012 increased its GDP more than 27(!) times (from $298 billion to $8,227 billion).[35] All those figures are very impressive indeed. For comparison, between 1986 and 2012 the GDP of the United Kingdom grew 4.3 times; whereas GDP of France and Germany only grew 3.4 times [calculated on the basis of data provided in World Bank 2014 (NY.GDP.MKTP.CD), see Fig. 4.5].

The developed countries could only preserve the gap through the prohibiting of the transfer of capitals, technologies and industries, through policies of high tariff barriers, that is by closing their markets from foreign goods. However, after decades when they tried to convince the developing world that the free trade is sacred, after the establishment of the WTO, it appears impossible for the developed countries to protect their markets with custom tariffs. What is more—customers in the developed

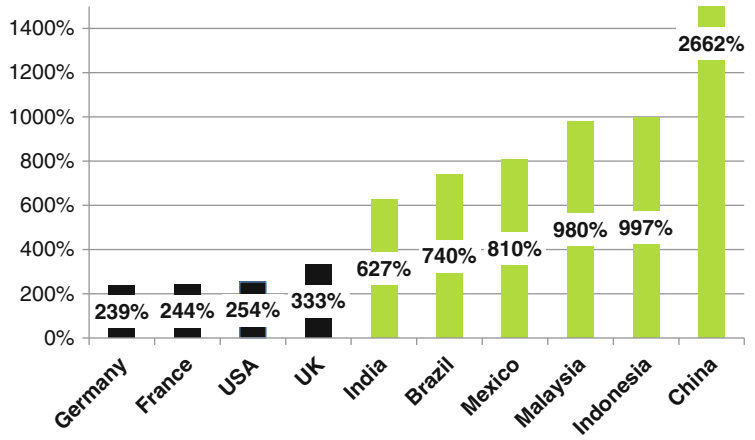

Fig. 4.5 GDP growth in some developed and developing countries between 1986 and 2012. *Data source*: World Bank (2014): NY.GDP.MKTP.CD

[35] All the calculations have been performed on the basis of the *World Development Indicators* database (World Bank 2014).

countries prefer to buy foreign but cheaper goods (first these were Japanese goods; then these were Taiwanese, Chinese and Mexican ones; now these are more and more goods from Bangladesh, Vietnam etc.).

Thus, we are dealing with a certain paradox of development. For a very long time the USA was a very active proponent of the ideology of the free trade and honest competition [for example, it constantly pressed upon such its partners as Japan that tried not to let to their markets certain goods (Bhagwati and Patrick 1991; Amsden 2004)]; it initiated the creation of respective international organizations. That time it was beneficial for the USA. However, those firm rules prohibiting the creation of artificial barriers blocking cheap imports became the basis for the rationalization of technological process and the transfer of production from Europe and North America to Mexico, China and other countries. Note that the behavior of the respective Western corporations was rather rational and logical; yet, as a result the West transferred to the periphery together with the industries a substantial part of its might.

As a result of the deindustrialization of the West, the developing countries have generally profited, whereas the developed countries found themselves in the trap of low growth rates. The process of deindustrialization (and its consequences) is described rather well by Martin and Schumann (1997) who see in it a global "trap" for Europe and the USA. However, those authors pay most attention to the issue of job cuts and wealth distribution; whereas they do not notice the global change of the balance of power, because they are sure that globalization brings negative results to all the countries of the world.

These were just Western and Japanese corporations that "impregnated" Mexican, Chinese, Indian and other developing economies. Western countries' policies together with global demographic changes (exhausting of the demographic bonus combined with the population aging of the West and the demographic bonus of the East) amplified those processes. Of course, if the Western leaders of the late 1980s and 1990s could realize entirely all the consequences of the deindustrialization, they might have done something to slow down this process[36]; however, they could hardly prevent it completely, taking into account the powerful influence of both consumers (≈electorate) and the financial-industrial elites. On the other hand, policies of a number of developing countries turned out to be rather successful as regards the support of industrialization and accelerating development of those countries.[37] Yet, without an adequate inflow of capitals and technologies from the developed

[36] Today the US administration tries to take certain steps in this direction, and Obama openly expresses his joy as regards the return of some industries to the USA.

[37] Note that a certain possible slowdown in the growth of developing countries turns out to be rather compatible with our idea that a new technological breakthrough (see Grinin and Grinin 2013 for more details) within the World System (that we expect to take place in the 2030s and 2040s) will request not only a certain decrease in the gap between the developing and developed countries (the economic convergence), but also a certain decrease of this gap in the sociopolitical and administrative dimensions (sociopolitical convergence), which may hinder the economic growth of respective developing countries, especially against the background of the World System reconfiguration that is likely to be generated by those processes (see Grinin and Korotayev 2012b for more details).

economies their success would have been rather limited. Such reforms only turn out to be successful only providing for favorable conditions.

Hence, precisely globalization played a decisive role in the weakening of the economic positions of the West in general, and the USA in particular (and, simultaneously, in the strengthening and rise of the countries of Asia and Latin America). We would forecast that the process of convergence will go very unevenly, in a wave-like manner, sometimes slowing down (up to temporary reversals), sometimes accelerating (see Appendix B for details). According to many forecasts, in the forthcoming decades one will observe a very significant reduction of poverty in the developing countries [according to some calculations it will decrease twice by 2030 (NIC 2012: 8)], the most notorious forms of exploitation will be eliminated, the illiteracy will be reduced very substantially, there will be serious progress with respect to gender equality, and so on.[38] This will result in a substantial reduction of the gap between richer and poorer countries. We can also forecast in a rather confidential way the growth of the group of middle income countries (see, e.g., Korotayev et al. 2011a, b, 2012; Korotayev and de Munck 2013; Grinin 2013). In some respects such an equalization of incomes appears to resemble the process of convergence as regards the standards of life of different strata in various modern western countries in the first two thirds of the twenty-first century (especially in conjunction with rather active processes of the middle class formation).

[38] However, in absolute figures the number of poor and illiterate people remains rather high. On the other hand, the fertility decline in the Third World is bound to contribute to the reduction of those figures.

Chapter 5
Afterword: The Great Convergence and Possible Increase in Global Instability, or the World Without an Absolute Leader

Why Has the Great Convergence Led to the Growth of Global Instability? Thus, the overall conclusion of our research is that in the foreseeable future we are likely to observe the processes of economic and socio-cultural convergence between developing and developed countries. However, this will simply be a general tendency. In reality, this kind of long-term process never goes (and basically cannot go) in a strictly linear and progressive way. Especially when you consider that such a convergence implies a very serious and dramatic transformation of the World System, its zones, as well as individual countries. In general, such changes can signify a reconfiguration of the World System and a difficult search for new principles of world order. On the one hand, it is obvious that the Western world, by the United States will not put up with the decrease (and—all the more—the loss) of its global leadership, and it can use a variety of soft and hard means to preserve this leadership, including financial measures, renunciation of already unfavorable agreements and even military actions. On the other hand, the achievement by these or other developing countries of sufficiently high levels of development can lead to serious internal crises within them in connection with the contradiction between the increasing level of cultural development (and especially the expectations) of the population and the archaic and undemocratic forms of government together with high levels of social/economic inequality. Under certain conditions this kind of stress can lead under certain conditions to unrest and revolutions, which, however, are not necessarily beneficial for the future development (see, e.g., Goldstone 2001, 2014) and can, on the contrary, drag society back (Grinin and Korotayev 2015). Especially if we take into account that the USA appears to be ready to actively use such situations in order to maintain its position as the world hegemon, encouraging such movements or even provoking them.

Aside from the above, the instability in the forthcoming decades may be further amplified by uneven development of different countries or groups (see below), the changes in the ethnic proportions of some societies, especially Western societies (and in particular the USA), the more active participation in the processes of

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globalization of the regions that are weakly involved in them in present, as well as by the state formation and nation building in the regions with weak traditions of statehood (Grinin 2012b), the struggle for regional leadership, as well as by the struggle evoked by the general trend toward the weakening of state sovereignty and natural attempts to save it (Grinin 2008b, 2011a, 2012a, b). Of course, the world will face in its full magnitude the problem of risks associated with global finance which, on the one hand, can cause new devastating global financial crises, but, on the other hand, is likely to lead to the search for new solutions in the field of global financial regulation. But these solutions are also directly linked with the processes of convergence, and their influence on the might of the Western powers. We could not address these problems in this book, yet we have examined some of them in other studies of ours (Grinin and Korotayev 2010a, b, 2011, 2012b, 2015; Grinin 2012a).

Serious Transformations Are Likely to Be Observed Within the Developing Countries Themselves The Great Convergence with its development becomes a more and more complex process. As a result, even the concept of developing countries under the influence of rapid and radical change is being transformed. In fact, we should talk now not about a single group of developing countries, but rather about a number of groups which are very different in terms of levels and potentials of their own development. The law of uneven development is represented here in its full power. In the recent decades we observe a clear divergence between middle income and low income countries (see *Appendix B* below and Korotayev and Zinkina 2014). And this divergence may continue for some time, as not all the least developed countries are ready for the take-off. This may be further aggravated by the point that these are the least developed countries where we observe the highest population growth rates (see Korotayev and Khaltourina 2006; Korotayev and Zinkina 2014; Zinkina and Korotayev 2014 for more details). However, there are some grounds to maintain that some time we will observe a certain equalization within the developing countries themselves. This equalization will manifest itself in the following: in the forthcoming decades an increasing number of the least developed countries (including the ones in Tropical Africa) will join the club of the fastest growing economies. Thus, the number of the countries belonging to the "bottom billion" is very likely to decrease in the forthcoming decades (and this will be only partly compensated by the extremely high population growth rates that are so typical of the least developed countries).

Thus the gap between low- and middle-income countries is likely to continue growing; but the number of middle-income countries will increase, whereas the number of the low-income countries is likely to decrease in the forthcoming decades. We will almost certainly observe the growth of the group of developing countries with per capita average annual income in the range not only over $1,150, but also in the range between 3 and 15 thousand dollars.

Therefore, there are grounds to expect a few more waves of the rise of peripheral countries (whereas the growth rates of the current leaders—China and India—will slow down). One may note rather bright perspectives for the growth of a large group of developing countries, including Vietnam, Bangladesh, Turkey, Indonesia,

Nigeria,[1] Malaysia and so on (note that those countries are already actively diverging investments and export shares from China).

The Great Convergence and New Technologies There is no doubt that new technologies can also significantly influence the situation in the world, although we do not expect a new technological breakthrough before the 2030s (see Grinin 2012a, b; Grinin and Grinin 2013, 2014 for more detail). Some researchers who study the perspectives of global technological development in the forthcoming decades have noted that the potential of the information-computer technological paradigm has already been exhausted to a considerable extent, whereas the new technological breakthroughs (that will presumably be based on the development of bio- and nanotechnologies) appear to be delayed (e.g., Maddison 2007, p. 72; Мельянцев 2009). Some researchers interpret this as an onset of the so-called "technological pause" period (Полтерович 2009). From our point of view such a delay is not coincidental.

Convergence of Development Levels Is Necessary for a New Technological Breakthrough The point is that the largest technological shifts emerge initially as economic sectors, and then they diffuse throughout economies for rather long periods of time (see, e.g., Modelski and Thompson 1996; Grinin 2012a; Grinin and Grinin 2013, 2014; Perez 2002, 2010, 2011, 2012). Currently, we observe the final phases of such a wave of diffusion as regards information-computer technologies. As regards financial technologies, such a diffusion may continue for some time. The analysis of emergence and diffusion of earlier waves of innovation suggests that a new wave of innovation does not start before certain equalizing of the technological level in a zone that is wider than the new innovation zone. For example, the cellular telephone could not emerge before the diffusion of previous modes of communication (including the traditional telephone). In addition, with every new major innovation wave the zone that is necessary for technological leveling expands (see Grinin 2007, 2012a, b; Grinin and Grinin 2013, 2014 for more detail). At present, due to the process of globalization, that particular zone has expanded to the maximum possible size. Finally, the level of technological reception in the largest part of the world is not yet sufficient, and this is why the main economic actors prefer to diffuse existing technologies rather than to create new ones. Thus, we suppose that it will take a rather long time before the next new technological breakthrough starts; and during this time we will observe both the processes of technological leveling and the incubation processes preparing for the emergence of new technologies (see *ibidem* for more detail).

Thus, a new advance of the Great Convergence is a necessary condition for the future technological breakthrough. After the beginning of a new wave of major technological innovations, the Great Convergence will enter a new phase, as the new generation of newly industrialized countries will be very likely to play an extremely important role in the development and spread of this new wave of innovation.

[1] However the Nigerian state and civil society need to achieve a radical reduction of dangerously high fertility rates in this country (see Zinkina and Korotayev 2014 for more details).

Economic Globalization Versus Political Integration of the World In general, we can say that in the present-day world political globalization lags far behind the economic globalization that has developed enormously in the recent decades (see Grinin and Korotayev 2012a, b, c, 2015; Grinin 2012a, b). The catching up of the political component with the economic component of globalization will imply the reconfiguration of the World System, which may turn out to be a rather painful process (*Ibid*.). The crises may occur in very unexpected parts of the World System. In particular, we tend to consider the Arab Spring, the crisis in Ukraine (which caused serious tensions between Russia and the West), as well as tensions along the Chinese borders as manifestations of such a reconfiguration of the World System. Of course, it is impossible to predict the specific forms (and more so results) of each individual crisis, interstate conflict and social upheaval, but we have substantial grounds to expect a very uneven multivector process, which is likely to mean in the end a movement toward a new world political order.

Thus, we expect that the process of convergence will lead not only to the victory over poverty, low levels of consumer culture and literacy in developing countries, but, unfortunately, also to a period of greater instability in the world. In this concluding chapter we will mention one aspect of the movement to the new political order, the contours of which are unclear. We will discuss the point that in the near foreseeable future, on the one hand, there will be a weakening of the leadership functions of the United States and the West (with active attempts on the part of both the United States and the West to keep them), and, on the other hand, no absolute leader will appear to replace the United States. Thus, the world will develop against the background of absent absolute leadership, which may further increase instability.

Will Any Country Be Able to Replace the USA? The development of the abovementioned trends the gradual convergence of the World System core and periphery connected with the weakening of the USA and the West (as we have seen it in Chap. 4), and the growing of the significance of many developing countries means that on a planetary scale we are dealing not just with major changes, but rather with a radical transformation of all the structure of the global economic and political order, and an overall rather complicated reconfiguration of the world.

Yet, how will this reconfiguration proceed? First of all note that though positions of the USA will be weakening, no state in the new world will be able to become the absolute leader. The idea that the position of the USA will be occupied by some other state (the most frequently proposed candidate is, of course, China) is utterly wrong. China will outrun the USA as regards GDP at PPP very soon and will outrun the it with respect to GDP in current US dollars perhaps within 5 or 10 years. However, this is utterly inadequate to become the absolute world leader. The matter is that today the USA concentrates simultaneously *almost all the aspects of leadership (political, military, financial, monetary, economic, technological, ideological, and cultural)*, whereas there is no country in the world (and there is no group of countries in the world) that in foreseeable future will be able to monopolize so many aspects of the world leadership (incidentally, this was suggested by

William R. Thompson already in 1988). In addition, neither China, nor India (nor any other country) will be able to afford such a heavy burden due to the lack of appropriate economic possibilities as well as political risks [at least because of the problems with poverty of substantial parts of respective populations and discontent with social problems, but also due to the lack of experience and necessary alliances, as well as ideological weakness (see Grinin and Korotayev 2010b, 2011; Grinin 2011b, 2013 for more details)].

How Would the Future World Look Like? *One may expect that the forthcoming global system will have the following three characteristics: (1) changing rules and flexibility of structures of the World System, (2) activation of the struggle for allies, and (3) the reduction of a country's sovereignty.* The absence of the strong absolute leader will lead to the growth of the World System flexibility as regards the search for new political foundations. As we have already noticed earlier (Grinin and Korotayev 2010a, b; Grinin 2010; Гринин, Л. Е 2013), the struggle for an "honorary" place within the globalization and coalitions, organization and functioning of the new world order will lead to the beginning of what we have called *the epoch of new coalitions.* In the process of the search for the most stable, advantageous and adequate forms of supranational organization one may expect to observe the emergence of various and even fast changing intermediate forms when actors in global and regional political arenas will look for the most profitable and convenient blocks and agreements. However, finally some of those new alliances and coalitions will transform from temporal into permanent arrangements creating some fixed supranational forms.

Thus, in the forthcoming decades one will see the emergence of a number of countries and alliances that will play leading roles in different respects; against such a background the winners might be those countries that will conduct the most active policy aimed at the formation of new blocks as well as the joining of new blocks, those countries that will be able to get the maximum number of partners in various spheres. It may be said that a country's influence will grow through "getting points" by its participation in various alliances and blocks.[2] For the largest actors one is likely to observe a high degree of competition as regards attempts to influence the restructuring of the international system.

Consequently, we will live in such a world, where one can witness a more and more active search for allies and alliances (though this might be accompanied by the growth of competition in many respects); this can result in the emergence of some institutional factors of the new world order that imply the need for a greater stability (Grinin 2012a, b). Naturally, it appears impossible to predict concrete combinations of future alliances. However, it is possible to offer a few ideas about this. For example, we believe that scenarios suggesting the global dominance of the alliance of India and China are not realistic. However, there are some more realistic scenarios—for example, the ones with the USA and the West maneuvering between the

[2] This may be also done through the formation of new alliances (the emergence of the BRICs, and then the BRICS is very symptomatic in this respect).

alliances with India, China, and other large developing countries and their blocks. As a matter of fact, in recent years we have been observing the growing activity of US foreign policy aimed at the neutralization of the Chinese influence (through the attempts to strengthen contacts with India and other Asia-Pacific actors). It is also worth noting a rather old (and additionally consolidated by the Arab Spring) alliance of the USA and the Gulf States.[3]

On the other hand, we are currently seeing attempts to establish alliances between various other powers (Russia, China and the other BRICS countries, Argentina and the other Latin American countries, which, for one reason or another, may be wary of the West) in order to create a new center of power in the world. This only confirms that in the near future alliances may be unexpected and unstable, which does not preclude the formation of more stable alliances on this base.

All the above described processes will also lead to a certain transformation of national sovereignty that will generally weaken due to the explicit and implicit, forced and voluntary delegating of some parts of sovereign prerogatives to various international, supranational, and global entities and arrangements (see Grinin 2008b, 2012a, b for more details).

The weakening of sovereignty may be accompanied by the growth of national self-consciousness and nationalist moods in some developing countries with intensifying industrialization (see Grinin 2012a, b for more details). In the forthcoming decades the depth of economic links will increase, which will make a powerful influence on those developing countries (especially in Tropical Africa) whose population mostly does not feel those links yet in a substantial way. As a result, the struggle between traditionalism and globalization may intensify. In some areas conflicts and instability may grow, and whole regions may experience powerful social destabilization waves [as was observed in the case of the Arab Spring (see, e.g., Grinin and Korotayev 2012b; Korotayev et al. 2011c)].

New Geopolitics and the End of the Epoch of Stable Political Blocks For many decades one of the main factors of the emergence of political alliances was the threat of war which dictated selection of certain allies. That is why political alliances were mostly military-political. In the contemporary world the risk of the large-scale war has diminished significantly, whereas the economic interdependence between countries has increased dramatically, and it will continue to grow in the forthcoming decades.

Unfortunately, military conflicts or interventions have not disappeared, and in recent years, we deal quite often with the use of force or threat of force. Moreover, crises (for example, the Ukrainian one), may help military alliances to strengthen their positions.

Nevertheless, there certain grounds to maintain that the old style of geopolitics gradually has to give way to a new style of geopolitics connected with the necessity

[3] But today, there are some visible signs of cooling between the USA and Saudi Arabia, as they become to a certain extent competitors in the oil market, and also because of the USA attempts to flirt with Iran. Politics has always been volatile, but probably it will become even more volatile.

to create optimum conditions for the economic development of a state or a group of states. Features of this new geopolitics look rather vague at present, but they should become much clearer in the forthcoming decades. Let us outline a few of them.

The epoch of firm alliances and inter-allied loyalty appears to be coming to the end (a characteristic example is Washington's refusal to support Pakistan and the USA alliance with India). The selection of allies, partners and blocks will be more and more determined by rapidly changing interests and conjunctures. But, of course, more powerful partners will use various means to keep their wavering partners in their zones of influence.

States will not look for constant allies; they will rather be looking for temporary "fellow travelers" for particular occasions, trying to reach agreements simultaneously with many partners (this corresponds well to one of the principles of modern business—to have as many partners as possible). Even now many experts are concerned with the future of international system if it is only based on interests, not on certain rules (see NIC 2012).

Economic interests will be clearer expressed in the foreign policy. Thus, economic interests of some countries may become constant, whereas political interests may be adjusted to them to a considerable degree. Political and geopolitical principles and interests of some other states (especially larger ones) will never be dissolved in economic aspects. However, in this case different vectors of foreign policy may turn out to be pulled apart, that is, political and economic aspects of foreign policy will exist more detached from each other. And, consequently, policies will become more pragmatic than now.[4]

The epoch when the creation of economic blocks was determined to a very considerable extent by some (civilization, ideological, military-political etc.) proximity evidently passes away. Today we see a growing tendency toward the situation when close economic links do not necessarily imply any political or ideological partnership, though they may impede outbreaks of open conflicts.

Consider this using China as an example. Its political influence is growing. In which way is this taking place? China has to join various alliances or to establish with them (e.g., with the ASEAN) special relations, as it tries to play there an important role. It also tries to initiate and actively support various economic agreements (e.g., regarding free trade with Japan and Korea). China also tries to push the RNB as an international currency (note, e.g., recently signed agreements with Brazil and Australia), but to achieve this China must activate its agreements with numerous countries, simultaneously making concessions to them, and getting such concessions from them. However, notwithstanding all the active economic policy pursued by China, notwithstanding all the growth of trade with its neighbors, this did not eliminate the political (and territorial) contradictions with Japan, Taiwan, Vietnam, India and so on. Let us mention another example. The US "flirtation" with India implying a virtual permission for India to possess nuclear

[4] As a result both enmity and friendship may be forgotten very soon (one of salient examples is provided by Vietnam and the USA; they have forgotten their antagonism and are developing bilateral relations in a rather active way).

weapons do not imply that a sort of firm allied relations have been established between the two states.

Thus, the behavior in politics is becoming closer to business strategies where the principles are always rather fluid. However, new principles of the world order may start emerging just on this fluid soil.

World Network Community? In those historical periods when economic links between countries and regions were not as deep and indissoluble, the development of globalization needed a certain military and political hegemony that relied to a considerable extent on technological superiority of certain powers. At present the depth of economic relations has become unprecedented, which (as has already mentioned above) weakens the need in political and military hegemony in its present sense; this, of course, leads to more pragmatism in foreign policy.[5]

The same causes will influence the process of a particular shift toward the formation of a global network community (from the current hierarchical structure), within which (in addition to states and their blocks) an active role will be played by NGOs and many other actors. This process may also be regarded as one of the aspects of the leveling of degrees of economic development (this is likely to contribute to the establishment of a new basis of global relations, whose formation could facilitate the creation of conditions for the emergence of some effective global coordination center).

The movement toward the network society will contribute (in conjunction with the Great Convergence) to the growth of the world middle class, a sort of world citizen's class (NIC 2012, pp. 8–9), whose numbers, according to the Asian Development Bank, will grow at the rate of about 9 % annually. And, generally, even according to conservative models, by 2030 those numbers will double—from one billion to two billions. We tend to agree that this is a very important megatrend (*Ibid.*, p. 4). The idea that the middle class of different countries will potentially constitute a sort of global citizenship (which gives some hope as regards the emergence of a solid basis of economic, cultural, and even political unity of the world) appears rather interesting and stimulating. In the nineteenth century intellectuals in different countries started constituting some unity first within Europe, and later all over the world, thus paving the way toward the development of panhuman ideas and values (which were ultimately proclaimed at the level of UN declarations). In a similar way the world middle class may create new possibilities for globalization. It may be that due to this it will acquire new (more mature) features, moving toward the political globalization of the world, a world whose contours are not clear yet.

[5] But, of course, such changes will not go smoothly, as the USA will try by all means to maintain its influence.

Appendix A: Technological Innovation Activities in Britain and Other Western Countries (1400–1900)—A Quantitative Analysis

As has been shown in Chap. 2, as regards the scientific-technological innovation rates, Europe outpaced China (and the East in general) in the fifteenth century—see Fig. 2.6 ("Number of innovations in science and technology in Europe and China per half a century, 900–1600 CE"), which supports our idea that the Industrial Revolution started in Europe in the fifteenth century. It started in the belt that included the Netherlands, Southern Germany, Northern Italy, as well as some parts of France, Spain and Portugal. We suggest identifying the last third of the fifteenth century and the sixteenth century as the initial phase of the Industrial Revolution. During the sixteenth and the first half of the seventeenth century, the achievements of different European countries were consolidating and diffusing, thus creating a new foundation for growth. This phase of modernization (in terms of inventions) can be subdivided into two subphases: the first was characterized by comparable levels of technological innovation activities in a number of European countries; at the second phase an undeniable lead belonged to Britain.

As regards technological innovation, a comparison of Britain with its European neighbors very clearly shows that the British lead began to appear only in the second half of the seventeenth century (Figs. A.2, A.3, A.4, A.5 and A.6; in Figs. A.4 and A.5 this can be seen particularly well). Before that, Britain clearly lagged behind Italy, Germany, and (for some period) the Netherlands. Thus, it is clear that during the two initial centuries of the Industrial Revolution Britain absorbed the achievements of European societies, and only then it was able to start its own innovative climbing. This British lead gradually grew until it reached its peak in the second half of the eighteenth century. But this superiority could not continue too long. Already in the first decades of the nineteenth century it became visible that some other European countries and the USA were trying quite successfully to catch up with Britain (Figs. A.6 and A.7), and in the second half of the nineteenth century (from the 1860s) Britain ceased to be a technological leader, and its role in the global technological invention process decreased from decade to decade. The technological leader role started to be performed by the USA (see Figs. A.7 and A.8).

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We emphasize again that, on the one hand, we see an evident technological innovation leadership of Britain for two centuries (from the second half of the seventeenth century to the first half of the nineteenth century); but, on the other hand, for a greater part of this period, the overall innovation activity of "the rest of the West" was higher than the one of Britain (Figs. A.9 and A.10). Thus, the primacy of Britain in the technological invention field was relative, except for only one relatively brief period of the second half of the eighteenth century and the early nineteenth century—i.e., the period of the final phase of the Industrial Revolution, when the leadership of Britain was absolute (Figs. A.9 and A.10).

Methodology The main database used for calculations in this appendix is Hellemans and Bunch (1988), which was augmented with data from Usher (1954), Haustein and Neuwirth (1982), van Duijn (1983), Рыжов (1999), Silverberg and Verspagen (2003), Ballhausen and Kleinelümern (2008), Challoner (2009) and Kondratieff (1926, 1935, 1984). In this appendix we have only taken into account technological inventions, excluding purely scientific discoveries (note that in diagrams in Chap. 2 we try to quantify the innovation dynamics in science and technology—hence, there we take into account both technological inventions and scientific discoveries). In addition, in this appendix we take into account only those inventions that were actually implemented within a century (thus, we do not take into account those sketches of Leonardo da Vinci that remained on paper only). With regard to scientific discoveries, the only exception was made to those of them with a direct technological significance.

For the initial phase of the Industrial Revolution and the first half of its intermediate phase (the fifteenth, sixteenth, and seventeenth centuries), we have identified five major players in the technological innovation sector: Italy, Germany, France, the Netherlands, and Britain (Figs. A.1, A.2, A.3 and A.4). Of course, some important technological inventions were made in some other European countries (see Figs. A.6, A.7 and A.8), and their total number exceeded in the fifteenth and sixteenth centuries the one recorded for France. But in general, they did not play any significant role until the early eighteenth century. Their role began to grow afterwards, which confirms our idea of a common European space for open innovation during the Industrial Revolution. Figures A.6, A.7, and A.8 clearly demonstrate that in the eighteenth century the total number of major inventions made in the rest of Europe (including Russia) exceeded the number of innovations in such a former leader as Germany, in which the innovative activity in the technological area during this time slowed down.

For over a century and a half (until the early seventeenth century) Italy remained the technological innovation leader. It also fully corresponds to an important fact which was mentioned in Chap. 2—it is in Italy (especially in Venice) where in the fifteenth and sixteenth centuries one could observe the most advanced legislation and practice for registering inventions. However, the growth of its activity stopped in the middle of the sixteenth century, while other countries were catching up with Italy. The stagnation of the innovation activity in Italy correlated quite well with the

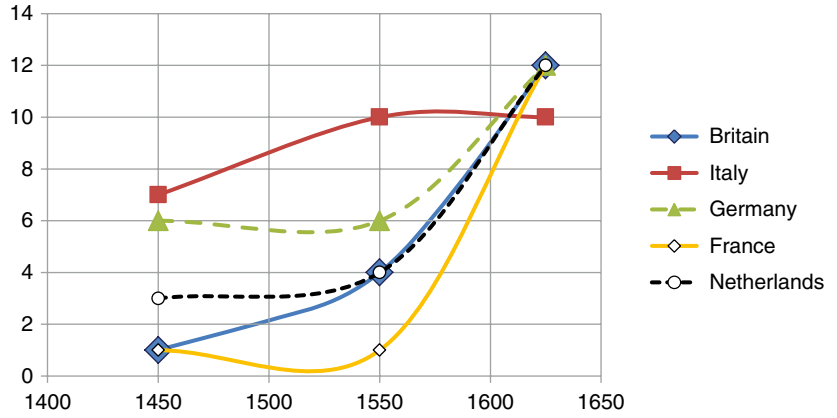

Fig. A.1 Dynamics of technological inventions (=endogenous technological growth rate) in five leading countries of Early Modern Europe, 1400–1650. *Note*: the data source is Hellemans and Bunch 1988. Datapoints for 1450 refer to the fifteenth century, datapoints for 1550 refer to the sixteenth century, datapoints for 1625 refer to the first half of the seventeenth century. The diagram indicates the number of important technological innovations (listed in our database) made in respective countries per century. If a database refers for half a century, we provide the endogenous technological growth rate as inventions per century (to make all the datapoints comparable). Hence, for the Netherlands, the datapoint for 1450 indicating "3" means that for the fifteenth century our database lists three discoveries (which yields a "3 inventions per century" growth rate"), for sixteenth century it increases to "4 per century"; for the first half of the seventeenth century our database records six inventions in the Netherlands, which yields for the Netherlands for 1600–1650 the endogenous technological growth rate of "12 inventions per century"

start of economic and political crisis, associated with changes of world trade routes, its inability to change the political model of development and foreign policy challenges. At the same time, we note that future long-term leaders in innovation, Britain and France at the start of the Early Modern Period were lagging far behind Italy and Germany (Figs. A.1 and A.2, A.3 and A.4).

Figures A.1, A.2, A.3, A.4 and A.5 indicate a rather interesting point, as in the early seventeenth century four European powers converge as regards the number of important innovations per country, which supports the idea that for the seventeenth century it is quite possible to speak about a general Western European level of technological innovation activity. Although the further development of innovative activity in different countries was rather different, it is evident that a certain base was established at a fairly high level, which was necessary to begin a new breakthrough, a new phase of the Industrial Revolution. Also Figs. A.3 and A.4 show quite clearly the stagnation of Italy, where in the seventeenth century the technological innovaton activity rates fell almost to zero, which correlated quite well with the political and social decline of Italy. Innovative activity from the south of Europe moved to the North-West (including France) (see Fig. A.2).

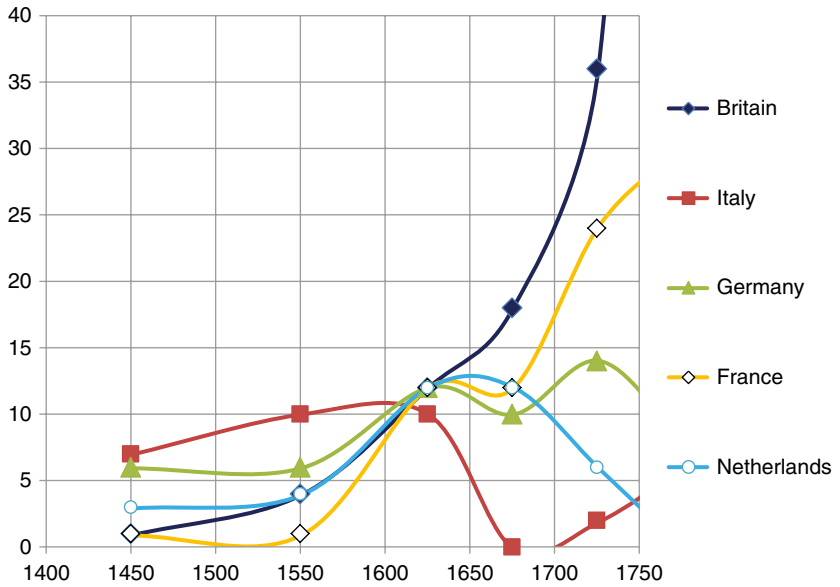

Fig. A.2 Dynamics of technological inventions (=endogenous technological growth rate) in five leading countries of Early Modern Europe, 1400–1700. *Note*: datapoints for 1625 and 1675 refer to the first and the second half of the seventeenth century respectively. Recall that in such cases we still measure the endogenous technological growth rate as inventions per century (to make all the datapoints comparable). Hence, for example, for the first half of the seventeenth century our database records six inventions for Germany, which yields for Germany for 1600–1650 the endogenous technological growth rate of "12 inventions per century". For the second half of the seventeenth century five major inventions are recorded in Germany, which yields for Germany for 1650–1700 the endogenous technological growth rate of "10 inventions per century", etc

In the first half of the eighteenth century a certain divergence was observed in the European North-West itself. The endogenous technological innovation rates grew very substantially in France, but especially in Britain (see Fig. A.3).

Thus, already in the first half of the eighteenth century the British technological lead became quite visible. But it only became really absolute in the second half of the eighteenth century (see Fig. A.4).

As we see, in the second half of the eighteenth century in Britain the endogenous technological growth rate increased by more than 250 %. This happened against a rather slow growth of this indicator in France, a weak recovery in Italy and clear decline in Germany and especially the Netherlands. As a result, the technological lead of Britain became almost absolute—in the second half of the eighteenth century the overwhelming majority of all the important technological inventions were made in Britain (see Fig. A.9). The enormous lead of Britain with respect to the technological leaders of the start of the Early Modern Period becomes especially visible if we delete the French curve from our graph (see Fig. A.5).

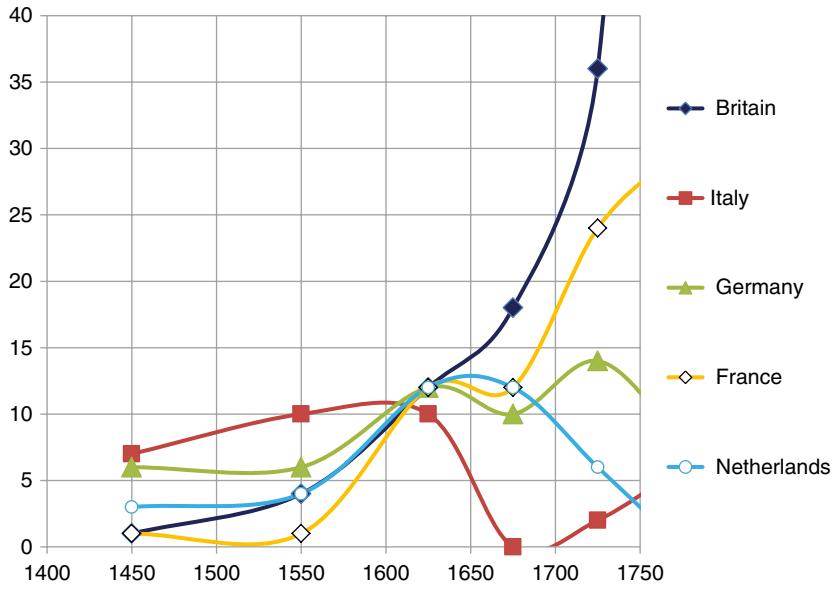

Fig. A.3 Dynamics of technological inventions (=endogenous technological growth rate) in five leading countries of Early Modern Europe, 1400–1750. Change of the leaders

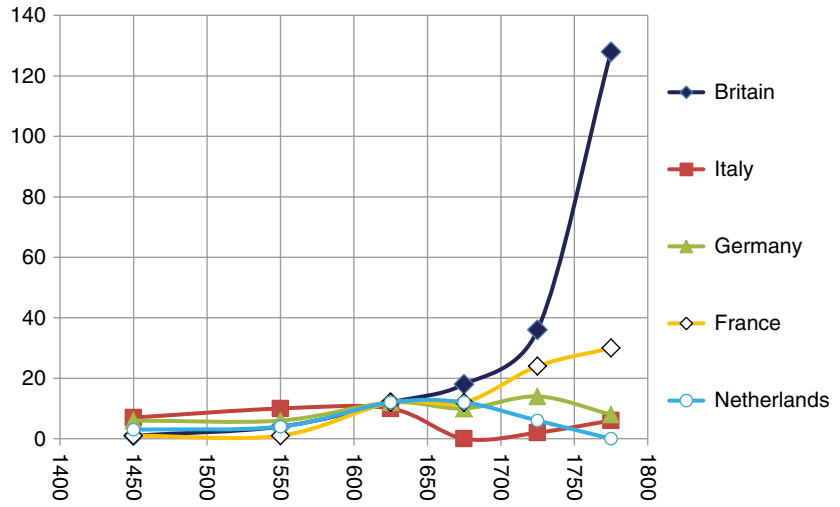

Fig. A.4 Dynamics of technological inventions (=endogenous technological growth rate) in five leading countries of Early Modern Europe, 1400–1800. The absolute technological lead of the British in the late eighteenth century

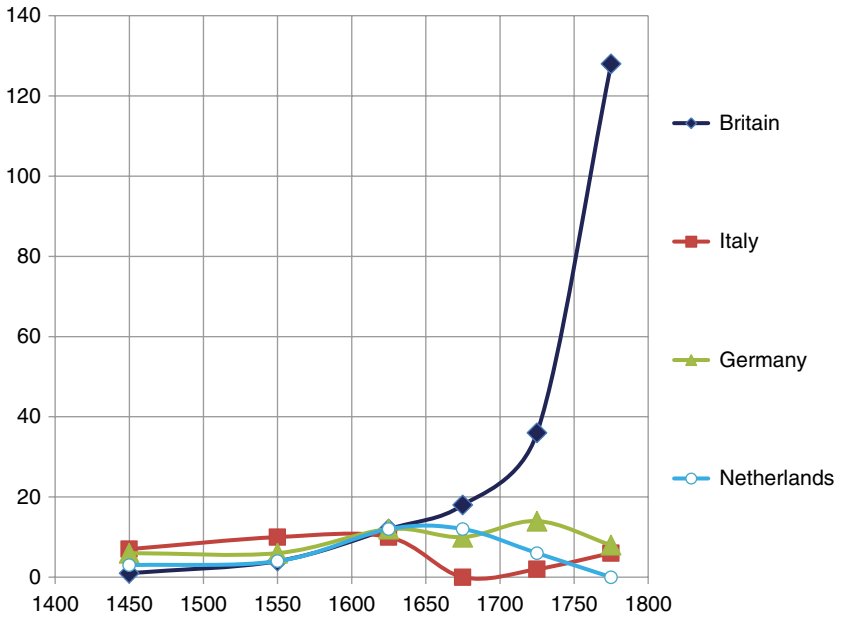

Fig. A.5 Dynamics of technological inventions (=endogenous technological growth rate) in four leading countries of Early Modern Europe, 1400–1800. With France excluded the absolute technological lead of the British with respect to Germany, the Netherlands and Italy in the late eighteenth century looks even more salient

However, this British absolute technological prevalence continued just for half a century. Already in the first half of the nineteenth century the British endogenous technological growth rate virtually stagnated against the background of a very fast increase in those rates in France, Germany and the USA, as a result of which those countries caught up with Britain in a rather significant way (see Fig. A.6), whereas the number of major inventions made outside Britain exceeded substantially the number of British inventions (Fig. A.10).

In the first half of the nineteenth century the Industrial Revolution was completed. Figures A.1, A.2, A.3, A.4, A.5 and A.6, as well as Figs. A.9 and A.10 in different projections well confirm our idea that the Industrial Revolution from the fifteenth to the nineteenth century passed through three phases: initial, intermediate, and final.

In the second half of the nineteenth century Britain finally lost its technological lead, as in the late nineteenth century the number of major inventions made in each of the USA, Germany, and France exceeded the number of British inventions (see Fig. A.7), whereas in 1880–1900 the number of major inventions made in Britain constituted just about 10 % of all the major inventions made in the West (see Fig. A.10). The technological lead by the end of the nineteenth century was clearly taken by the USA (see Fig. A.7).

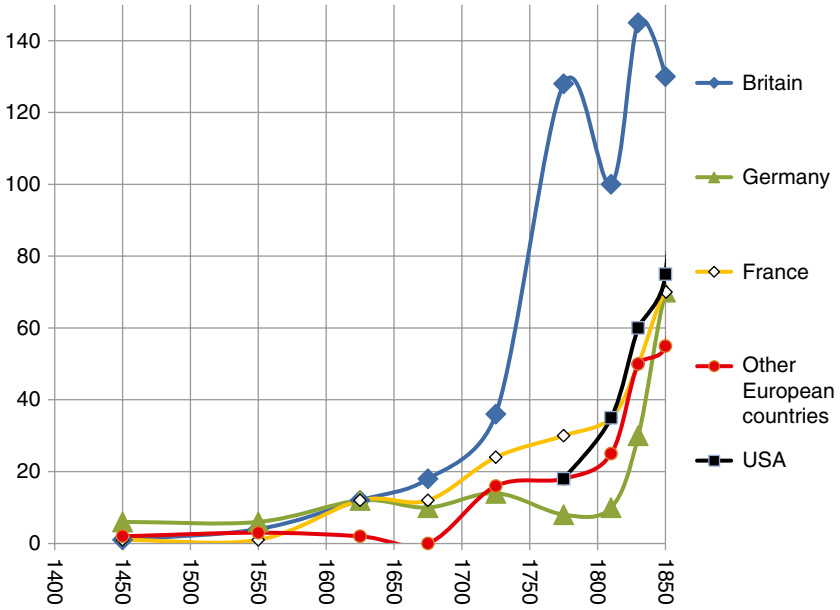

Fig. A.6 Dynamics of technological inventions (=endogenous technological growth rate) in Europe and the USA, 1400–1850. A few Western countries are catching up with Britain in the first half of the nineteenth century

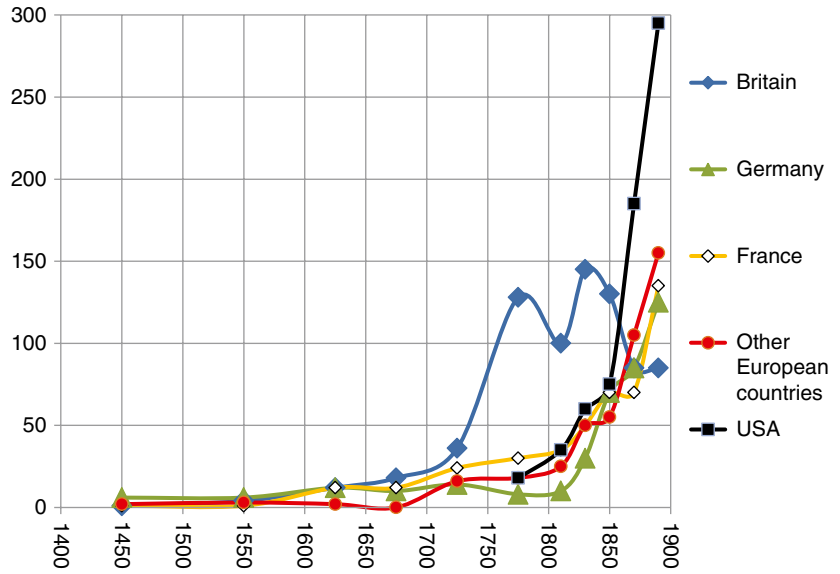

Fig. A.7 Dynamics of technological inventions (=endogenous technological growth rate) in Europe and the USA, 1400–1900. Convergence among the leading European countries and the USA lead in the second half of the nineteenth century

We continue to talk about the three phases of the Industrial Revolution as an interconnected process, during which, however, technological leaders were changing, which is quite clearly reflected in Figs. A.7 and A.8. At the initial phase (1450–1600), we already see a fairly high rate of technological innovation activity (especially in comparison with earlier periods that preceded the onset of the Industrial Revolution), which further increased during the second half of the sixteenth century. This indicates a transition to the intermediate phase when the base of the industrial revolution greatly increased. As we remember (see Figs. A.1, A.2, A.3 and A.4), at this phase technological leaders were Italy and Germany, but one could also observe a gradual growth of the role of some other European countries: England, France and the Netherlands. However, in the late sixteenth century it was not clear yet which country would be the future leader. The intermediate phase was characterized by the emergence of new centers of technological innovation, as well as by the dissemination and improvement of previous innovations. Important improving inventions were made, which were extremely important for the future of the Industrial Revolution. The dynamics of the process was not linear, as the further development of the technology base required a serious political change. This is quite visible in the diagrams (e.g., Figs. A.3 and A.9). First, we see a general continuation of the innovation activity growth in the first half of the seventeenth century (except Italy, which in terms of invention rates stagnated—though still at a rather high level) and the convergence of the endogenous technological growth rates on all the main countries of Western Europe. In the second half of the seventeenth century in all the main Western European countries (except Britain) the technological invention activity stagnated or even decreased, yet it generally remained higher than at the previous (initial) phase of the Industrial Revolution. In Germany, after a certain decline in 1650–1700, it somehow increased in the first half of the eighteenth century, but Germany was no longer one of technological leaders of Europe. Real technological innovation rise started there only in the first half of the nineteenth century. However, during this period (the seventeenth century and the first half of the eighteenth century) a number of important innovations in military tactics and strategy as well as in international relations were made, which, however, by definition, we could not reflect in our calculations. In any case, in the seventeenth century in Britain (notwithstanding the political revolution and civil war) the technological invention activity did not stagnate or decrease at all; what is more, it increased very significantly, indicating the preparation of the technological breakthrough in Britain (to some extent this was also a reflection of legislation on patents and monopolies that was enacted in the early seventeenth century). Nevertheless, it is clear (see Figs. A.9 and A.10) that in the seventeenth century and even in the first half of the eighteenth century, the total invention activity of Continental Europe was substantially greater than the invention activity of Britain alone. In addition, two other new technological innovation leaders emerged in the seventeenth century—the Netherlands and France, which reflected the well-known World System hegemony of the Netherlands in this century (see, e.g., Braudel 1981–1984; Arrighi 1994; Modelski 1987, 2006; Modelski and Thompson 1996) as well as military-political growth of France [this, in its turn, reflected the growing might of France as the leading continental power,

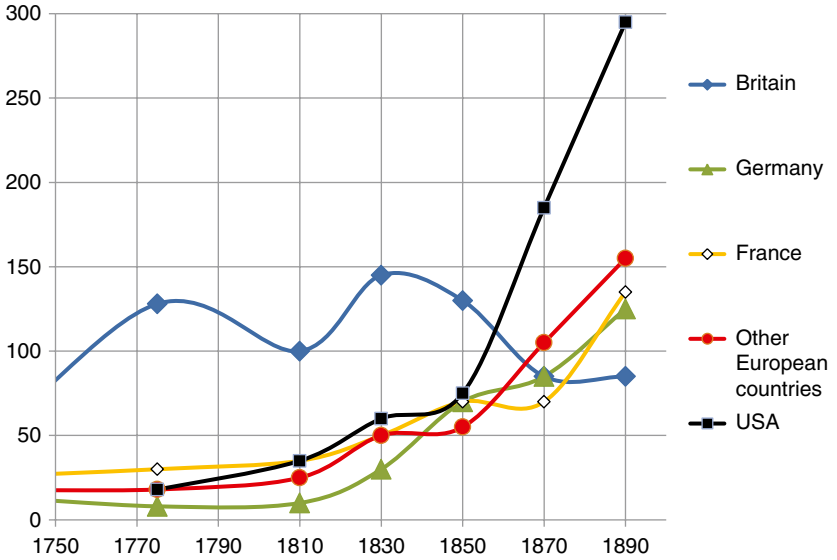

Fig. A.8 Dynamics of technological inventions (=endogenous technological growth rate) in Europe and the USA, 1750–1900

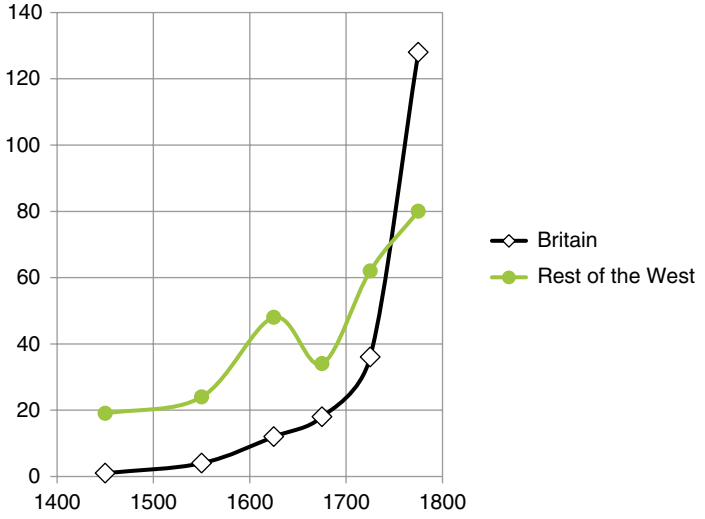

Fig. A.9 Comparison of technological innovation rates in Britain and the rest of the West, 1400–1800

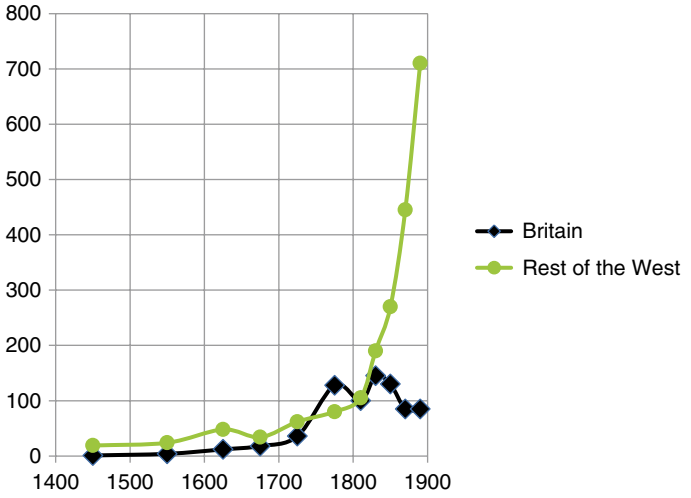

Fig. A.10 Comparison of technological innovation rates in Britain and the rest of the West in 1400–1900

which was the first in Europe to create a new type of state—a mature state (see Гринин 2011; Grinin and Korotayev 2006; Grinin 2012a)].

Return now to the idea of comparing Britain with the rest of the West (Figs. A.9 and A.10). As we can see, before 1650 the number of major inventions made in Britain was a few times less than in the rest of Europe; in 1650–1750 this gap decreased very significantly, but still the number of major inventions made in the Continent substantially exceeded the number of such inventions made in the British Isles. We draw attention once again to the point that the overall growth of innovation in Continental Europe slowed down very substantially in the period after the 30 Years War (and in Britain despite its revolution the technological innovation continued to accelerate). A new wave of invention activity growth started in the European Continent in the first half of the eighteenth century (see Fig. A.9). However, in the second half of the eighteenth century one could hardly observe in Continental Europe anything comparable with the explosive growth of major technological inventions that was observed in Britain during this period of time (corresponding to the industrial breakthrough). In the second half of the eighteenth century Britain became an absolute global technological leader, the main engine of world technological progress. But if we look at Fig. A.10, we can clearly see that in the overall picture of the Industrial Revolution this is a relatively short period when Britain had an almost total global superiority in the field of technological innovation, when more technological inventions were made in Britain than in the rest of the world. Already in the first half of the nineteenth century, a few Western countries managed to catch up with Britain in a very significant way, and by the end of the nineteenth century the USA, Germany, and France were outperforming Britain. Just because

many countries of Continental Europe (as well as the USA) were ready to use those possibilities that were opened by the Industrial Revolution, this revolution was able to produce a world historical effect.

So in conclusion, we note that the US coming to the first place with respect to technological innovation rates (Fig. A.8) meant not only the loss of leadership by Britain, but the fact of the formation of the West in the full modern sense of the word, of the West, which is not isolated only within Western Europe but includes North America, and Central Europe. And it meant the formation of the really well integrated World System.

Appendix B: A Mathematical Model of the Great Divergence and the Great Convergence—Demography, Literacy, and the Spirit of Capitalism

Reconsidering Weber[1]

In his classic *The Protestant Ethic and the Spirit of Capitalism*, Max Weber (1904[1930]) suggested that Protestantism stimulated the development of modern capitalism in Europe and North America. Weber disregarded the wide-spread explanation of economic success of the Protestants in Europe in the Modern Age as a result of their religious minority position. He pointed out that the German Catholics failed to achieve similar results despite being a religious minority in many parts of Germany.

Weber explained the significant differences between Catholics and Protestants in their social status and economic success by the different world views inherent in the doctrines of these two confessions. He suggested that a decisive role was played by the formation of a peculiar "spirit of capitalism", which implied the devotion to one's business, the desire to increase one's wealth in an honest way and so on. According to Weber, the spiritual basis of capitalism was grounded in the vulgarized versions of the theology of Calvinism and some other Protestant sects. It was, above all, the belief in predestination and (in vulgarized versions) in the possibility to obtain the signs of whether one is predestined to salvation via perfection in one's profession.

Many of Weber's followers used to exaggerate the effect of religious ethics on the economic dynamics. Yet, Weber himself wrote:

> "… however, we have no intention whatever of maintaining such a foolish and doctrinaire thesis as that the spirit of capitalism… could have only arisen as the result of certain effect of the Reformation, or even that capitalism as an economic system is a creation of the Reformation" (Weber 1930[1904]: 91).

[1] This section has been prepared on the basis of Chap. 6 of our monograph *Introduction to Social Macrodynamics: Compact Macromodels of the World System Growth* (Korotayev et al. 2006a) that has been written in collaboration with Daria Khaltourina.

L. Grinin, A. Korotayev, *Great Divergence and Great Convergence*,
International Perspectives on Social Policy, Administration, and Practice,
DOI 10.1007/978-3-319-17780-9

Yet, this doctrinaire thesis is still frequently attributed to Weber [see, e.g., Maddison (2001: 45), or Landes (1998)]. At the same time Weber, in our opinion, showed quite convincingly that the processes of religious evolution could produce some independent effect on socioeconomic development. On the other hand, the mathematical model presented below in below in the section on "A Mathematical Model of the Great Divergence and the Great Convergence" in the present suggests another explanation for the correlation between the spread of Protestantism and some increase in economic development, which was noted by Weber (see also Korotayev et al. 2006a).

As is well known, the human capital development has been suggested as one of the most important factors of economic growth, whereas education is considered to be one of the most important components of human capital (see, e.g., Schultz 1963; Denison 1962; Lucas 1988; Scholing and Timmermann 1988 etc.). We tested our model below in the next section of the present *Appendix* and one of the assumptions of this model was a significant positive effect of literacy level on the economic growth during the modernization period. The model based on this assumption correlates well with the historical data on the demographic, economic, and educational dynamics of the World System (see below). Consequently, this hypothesis has passed a preliminary testing. Let us also test it using cross-national data.

In the twentieth century, mass literacy spread around the globe, and nowadays the differences in literacy levels between different countries tend to dissolve. At the same time, according to our hypothesis, the differences in various countries' economic development during the process of Great Divergence were rooted in the period of the beginning of modernization era. Therefore, it seems reasonable to investigate the connection between such indicators as GDP per capita in 2000 and the literacy level in the early nineteenth century.[2] For the data on these variables, as well as on GDP per capita in the early nineteenth century, see Table B.1.

Note that a statistical test of this dataset generally supports Allen's (2009, 2011) hypothesis that the average income level in a country in the early nineteenth century is regarded as the main predictor of its average income level around year 2000 (see Fig. B.1).

As we see, in our case the correlation in the direction predicted by Allen's hypothesis, has again turned out to be quite strong ($r = 0.65$) and statistically significant ($p = 0.02$).

However, what is even more important is that the per capita GDP levels in 1800 correlate positively and in a statistically significant way with the average annual per capita GDP growth rates in the subsequent two centuries (1800–2000) (see Fig. B.2):

What is more, we believe that Allen's explanation for this correlation is generally accurate. In the nineteenth century, with the onset of intensive global modernization, the countries with higher average per capita incomes (and, hence, with generally higher wages) had more incentives to introduce new labor-saving (and, hence,

[2] Since the indicators of educational level are strongly correlated with each other, the percentage of literate population seems to be a good integral indicator of the level of education for the early modernization period.

Table B.1 GDP per capita in the countries and regions of the World in 1800 [international $ 1980, PPP (Purchasing power parity)], GDP per capita in 2000 (international $ 2005, PPP) and % of literate population in 1800

Country/Region	GDP per capita in 2000 (international $ 1995, PPP)	GDP per capita in 1800 (international $ 1980, PPP)	Average annual per capita GDP growth rates in 1800–2000, %	% of literate population in 1800
USA	40,965	690	2.06	58
UK	29,445	1,030	1.69	55
Germany	30,298	790	1.84	55
France	28,210	750	1.83	38
Israel	23,213			(35)
Japan	28,889	420	2.14	33
Italy	27,717	670	1.88	30
China	2,667	500	0.84	20
Mexico	11,810	690	1.43	11
Brazil	7,906	580	1.31	8
Russia	8,613	488	1.45	8
India	1,745	440	0.69	5
Indonesia	2,679	425	0.92	5
Egypt	4,236	325	1.29	3
Sub-Saharan Africa	1,502			(1)

Note: The source of the data on GDP per capita and literacy rate in 1800 is Мельянцев (1996); on GDP per capita and the literacy rate in Russia in 1800 see Мельянцев (2003); on GDP per capita in the countries and regions of the world in 2000 see World Bank (2014): NY.GDP.PCAP.PP.KD. Our estimates are in *parentheses*

labor-productivity-increasing) technologies (that abundantly appeared in the nineteenth century); as a result, the productivity of labor (and hence, per capita GDP) grew much faster in those countries than in the countries where the average incomes (and wages) were lower (and where, as a result, the incentives to introduce labor-productivity-increasing innovations were weaker), which, quite predictably, produced an unconditional divergence effect (Allen 2009, 2011).

However, we believe that this factor was not the only one. Below, we will discuss another factor, which, as we will see, turns out to be much stronger than the one proposed by Allen. And this factor is just the literacy level.

The correlation between literacy rates in 1800 and per capita GDP in 2000 is presented in Fig. B.3.

Figure B.2 indicates that there is a very strong ($r=0.93$) and definitely significant ($p \ll 0.0001$) linear correlation between the literacy rate in 1800 and GDP per capita in year 2000. What is more, it is much stronger and more statistically significant than the previous correlation (see Fig. B.1). *R2* coefficient indicates that this correlation explains 86 % of the entire data dispersion.

However, what is even more important is that the literacy rate in 1800 correlates much stronger with the average annual per capita GDP growth rates in the subsequent

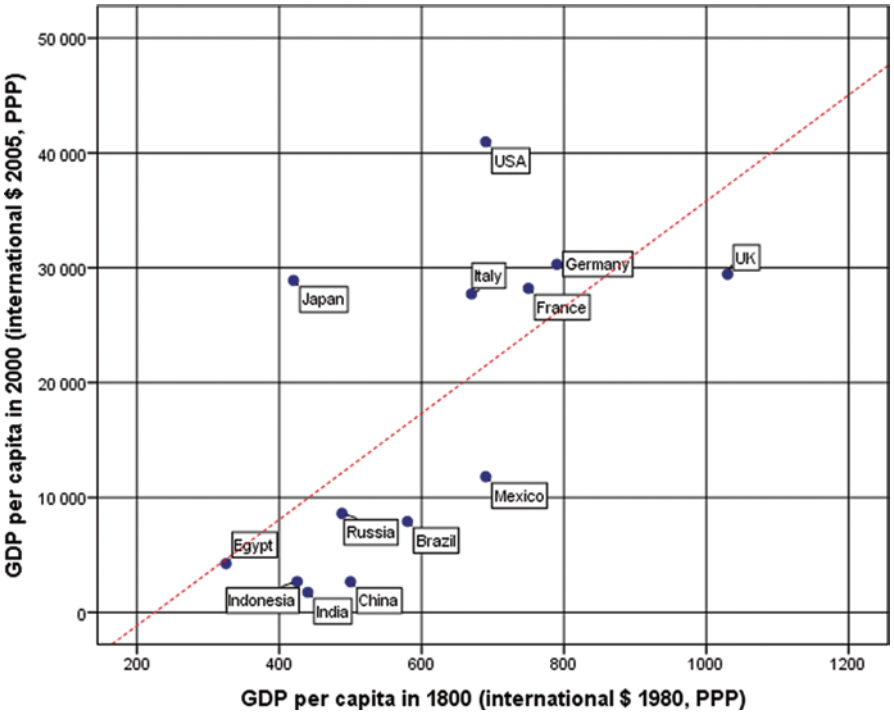

Fig. B.1 Correlation between per capita GDP in 1800 and per capita GDP Levels in 2000 (international $ 2005, PPP), scatterplot with a fitted regression line. *Note*: r = 0.65, $R^2 = 0.42$, $p = 0.02$

two centuries than the 1800 GDP per capita levels do (see Fig. B.4 and compare it with Fig. B.2).

Therefore, the hypothesis that the spread of literacy was one of the major factors of modern economic growth gains additional support. On the one hand, literate populations have much more opportunities to obtain and utilize the achievements of modernization than the illiterate ones do. On the other hand, literate people are characterized by a greater innovative-activity level, which provides opportunities for modernization, development, and economic growth.

Literacy does not simply facilitate the process of perceiving innovation by an individual. It also to a certain extent changes her or his cognition. This problem was studied by Luria, Vygotsky, and Shemiakin, the famous Soviet psychologists, on the basis of the results of their fieldwork in Central Asia in the 1930s. Their study shows that education has a fundamental effect on the formation of cognitive processes (perception, memory, and cognition). The researchers found out that illiterate respondents, unlike the literate ones, preferred concrete names for colors to abstract ones, and situative groupings of items to categorical ones (note that abstract thinking is based on category cognition). Furthermore, illiterate respondents would fail

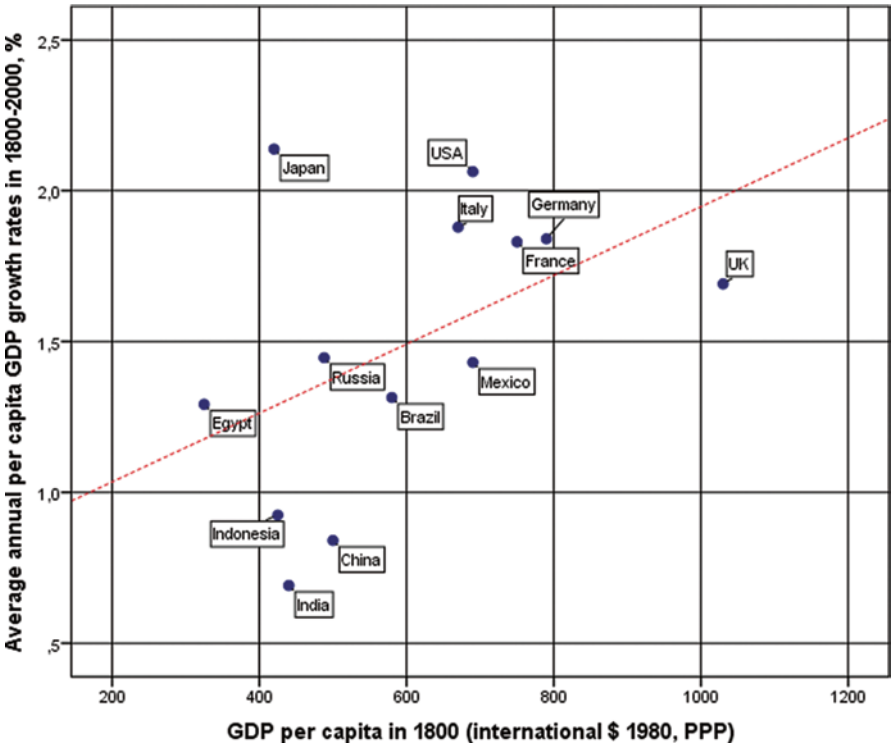

Fig. B.2 Correlation between per capita GDP in 1800 and average annual per capita GDP growth in 1800–2000 (%), scatterplot with a fitted regression line. *Note*: r = 0.47, $R^2 = 0.22$, $p = 0.05$ (1-tailed)

to solve syllogistic problems one of the kind: "Precious metals do not get rust. Gold is a precious metal. Can gold get rust or not?" These syllogistic problems did not make any sense to illiterate respondents because they were out of the sphere of their practical experience. Literate respondents who had at least minimal formal education solved the suggested syllogistic problems quite easily (Luria 1976; Лурия 1974, 1982: 47–69).

Therefore, literate workers, soldiers, inventors and so on turn out to be more effective than illiterate ones not only due to their ability to read instructions, manuals, and textbooks, but also because of the developed skills of abstract thinking. Some additional support for this could be found in Weber's work itself:

> The type of backward traditional form of labor is today very often exemplified by women workers, especially unmarried ones. An almost universal complaint of employers of girls, for instance German girls, is that they are almost entirely unable and unwilling to give up methods of work inherited or once learned in favor of more efficient ones, to adapt themselves to new methods, to learn and to concentrate their intelligence, or even to use it at all. Explanations of the possibility of making work easier, above all more profitable to themselves, generally encounter a complete lack of understanding. Increases of piece rates are

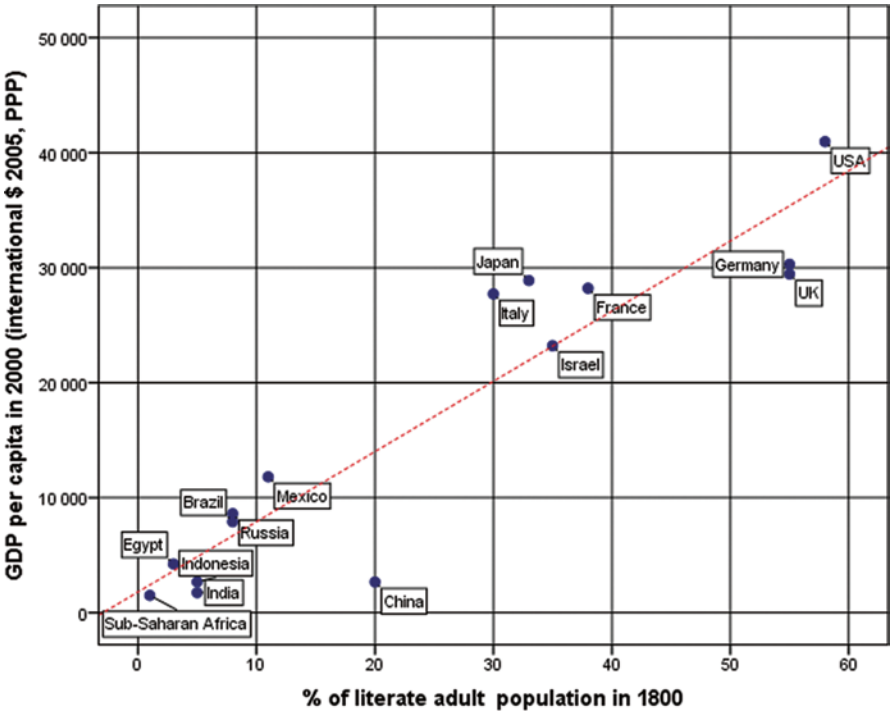

Fig. B.3 Correlation between literacy rates in 1800 (% of literate people among the adult population) and per capita GDP levels in 2000 (international $ 2005, PPP), scatterplot with a fitted regression line. *Note*: $r = 0.93$; $R^2 = 0.86$; $p \ll 0.0001$

> without avail against the stone wall of habit. In general it is otherwise, and that is a point of no little importance from our view-point, only with girls having a specifically religious, especially a Pietistic, background (Weber 1930[1904]: 75–76).[3]

We believe that the above mentioned features of the German female workers' behavior simply reflect a relatively low educational level of German women from labor circles in the late nineteenth—early twentieth centuries. The spread of female literacy in Germany and elsewhere lagged behind the male literacy (see Korotayev et al. 2006a, Chap. 7). In the early twentieth century, the majority of women could write and read only in the most developed parts of Germany (Мельянцев 1996). A more rational behavior of German workers from Pietistic circles could be easily explained by the special role of education in Protestants' lives.

The ability to read was essential for Protestants (unlike for Catholics) to perform their religious duty—to read the Bible. The reading of Holy Scripture was not just

[3] By the way, one can easily notice that these complaints on the working qualities of the German women workers resemble very much the complaints on the working qualities of the Indian workers made a few decades later and reported by Gregory Clark (2007: 353–357).

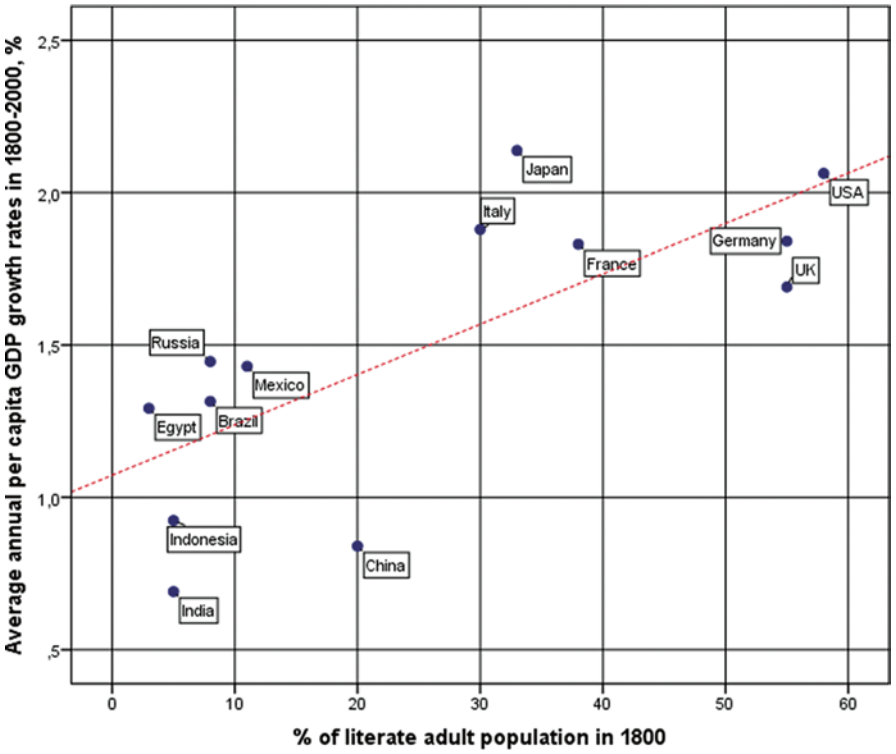

Fig. B.4 Correlation between literacy rates in 1800 (% of literate people among the adult population) and average annual per capita GDP growth in 1800–2000 (%), scatterplot with a fitted regression line. *Note*: r = 0.74; $R^2 = 0.54$; $p = 0.004$

unnecessary for Catholic laymen, for a long time it was even prohibited for them. The edict of the Toulouse Synod (1229) prohibited the Catholic laymen from possessing copies of the Bible. Soon after that, a decision by the Tarragon Synod spread this prohibition to ecclesiastic people as well. In 1408, the Oxford Synod absolutely prohibited translations of the Holy Scripture. From the very beginning, Protestant groups did not accept this prohibition. Thus, in 1522–1534, Luther translated into German first the New Testament and then the Old Testament, so that any German-speaking person could read the Holy Scripture in his or her native language. Moreover, the Protestants viewed reading the Holy Scripture as a religious duty of a Christian. As a result, the level of literacy and education was, in general, higher among Protestants than it was among Catholics and among the followers of other confessions that did not provide religious stimuli for learning literacy [see, for example: Малерб (1997): 139–157)].

In our opinion, this could to a considerable extent explain the differences between economic performance of the Protestants and the Catholics in the late nineteenth—early twentieth centuries in Europe noticed by Weber. One of Weber's research goals

was to show that religion can have an independent influence on economic processes. The results of our study support this point. Indeed, the spiritual leaders of Protestantism persuaded their followers to read the Bible not to support the economic growth but for religious reasons, which were formulated as a result of ideological processes that were rather independent of economic life. We do not question that specific features of Protestant ethics could have facilitated economic development. However, we believe that we found another (and probably more powerful) channel of Protestantism's influence on the economic growth of the Western countries.

In the next section of this appendix we will try to use these findings in order to develop such a mathematical model which is able to describe via six simple differential equations both the Great Divergence and the Great Convergence.

A Mathematical Model of the Great Divergence and the Great Convergence[4]

In this section we suggest a simple mathematical model that is capable to describe mathematically both the process of the Great Divergence and the one of the Great Convergence.

In this two-component model the world was divided into the core and the periphery. The core includes high income OECD countries (the USA, Japan, Western Europe, etc.). The periphery includes all other countries (except for post-socialist countries of Eastern Europe and former USSR).

For each of the two macro-zones the dynamics of three sub-systems are modeled: (1) population; (2) technological-economic sub-system; (3) education-cultural (human capital) subsystem. In initial conditions the level of the development of sub-system 3 is set for the core to be significantly higher than the one in the periphery. According to the model, the value of this variable affects positively the economic growth and it affects negatively the population growth (reflecting the negative impact of the female education on the fertility). On the other hand, the model describes the technological transfer from the core to the periphery (the catch-up term)—according to the model, the higher the level of the human capital in the periphery, the easier the technological transfer takes place; on the other hand, the larger is the gap between the core and the periphery, the higher is the value of the catch-up term; hence, the catch-up force is very low at the initial phase with the very low level of the human capital in the periphery, it becomes the highest at the advanced phase when a wide gap between the core and the periphery is combined with a rather high level of the human capital development in the periphery; and it decreases again at the final phase with the decrease of the gap between the developed and developing countries.

[4] This section has been prepared on the basis of Chap. 2 of our monograph *Mathematical Modeling and Forecasting of the World and Regional Development* (Коротаев и др 2010) that was written in collaboration with Justislav Bogevolnov and Artemy Malkov (see also Zinkina et al. 2014).

Note also that within the model the population growth is assumed to be affected positively by the economic growth, but, as the economic growth (both in the model and the real life) also promotes the development of the education, finally it leads to the decline of the population growth rates.

Within the model, at the first phase, the core's GDP grows much faster than in the periphery because of the high level of human capital in the core (which stimulates the economic growth there) and the low level of human capital in the periphery (which inhibits both the endogenous economic growth and the diffusion of the high technologies from the core). Within the model this generates the Great Divergence. Note that at this phase within the model the population in the core grows faster than in the periphery, because the high economic growth rates outweigh there the influence of the education that is not high enough there to inhibit sufficiently the population growth rates.

At the second phase, the economic growth rates in the periphery increase mainly due to the development of the human capital there, as this promote both the endogenous economic growth and the transfer of the high technologies from the core. However, at this phase the level of education in the periphery is not sufficiently high to inhibit decisively the population growth and to raise the economic growth rates to the core countries' levels; hence, at this phase the economic growth in the periphery leads to a very substantial population growth, but as regards the GDP per capita, the gap between the core and the periphery continues to increase.

Finally, at the third phase, the human capital in the periphery develops to such an extent that it allows simultaneously to achieve substantially high endogenous economic growth rates, very high levels of technological transfers (reflected in the high value of the catch-up term), and a significant slowdown of the population growth rates. As a result, at the third phase, the GDP per capita growth rates of the periphery start to exceed substantially the ones of the core—thus, the explicit Great Convergence begins within the model (note that the model also describes the fourth phase when the convergence rate slows down due to the decrease of the gap between the developing and developed countries, which leads to the decrease of the value of the catch-up term).

We start with the model (B.1)–(B.2)–(B.3) [for the description of its underlying logic see Korotayev et al. (2006a: 81–91)]:

$$\frac{dN}{dt} = aSN\left(1 - L\right), \tag{B.1}$$

$$\frac{dS}{dt} = bLS, \tag{B.2}$$

$$\frac{dL}{dt} = cSL\left(1 - L\right). \tag{B.3}$$

N is the population, L is the proportion of literate population, S is the "surplus" per capita product produced at the given level of technological development per capita

over the subsistence level[5]; *a, b, c* are constants. As we have shown earlier, this "macromodel describes rather well the modernization period, which appears to reflect the fact that [in this period] the development of human capital became the most important factor of economic development (see, e.g., Denison 1962; Schultz 1963; Scholing and Timmermann 1988; Lucas 1988 etc.)" (Korotayev et al. 2006a: 86).

The model also assumes that under certain conditions the periphery could "catch up" with the center through the diffusion of the technologies developed in the center (which actually proceeds along with the capital diffusion). Naturally, this phenomenon cannot be regarded unilaterally, as the diffusion of capital and technology to the periphery becomes possible only at both center's economic benefit (connected with the costs decrease) and at the appearance of a sufficient quantity of literate labor force in the periphery. Quantitative feature of the "convergence force" (*C*, "catch-up coefficient") was chosen as follows:

$$C = \frac{S_c - S_p}{S_c + S_p} \cdot L_p, \tag{B.4}$$

where

S_c is "surplus" GDP per capita over subsistence income in the core;
S_p is "surplus" GDP per capita over subsistence income in the periphery;
L_p is literacy rate in the periphery.

This equation reflects the following logic. On the one hand, the higher the difference in per capita incomes between the core and the periphery $\left(\frac{S_c - S_p}{S_c + S_p}\right)$, the stronger the "convergence force", as in this case the capital in the core has more incentives to move the production from the very high-wage core to the very low-wage periphery (together with investments and technologies). However, the strength of this force also depends on the level of the development of the human capital (which is measured in our model through the literacy rate *L*). Hence, even with a very high value of $\frac{S_c - S_p}{S_c + S_p}$ the convergence force will be rather low with a very low value of *Lp*. This reflects the point that even if wages in a certain region are very low, investments and capitals will hardly move there if the level of the human capital development is so low that it is unable to absorb the technologies moving from the core [Clark (2007, 359f) describes rather vividly how this happened in reality]. Thus, in the 1950s and 1960s the wages in South Asia were much lower than in South Europe; however, South Europe had at that time a much more developed human capital that allowed absorbing technologies from the most advanced Western economies much

[5] This level was estimated as 440 international Geary–Khamis 1990 dollars in purchasing power parity (PPP); for the justification of this estimate see Коротаев et al. (2007: 59–60).

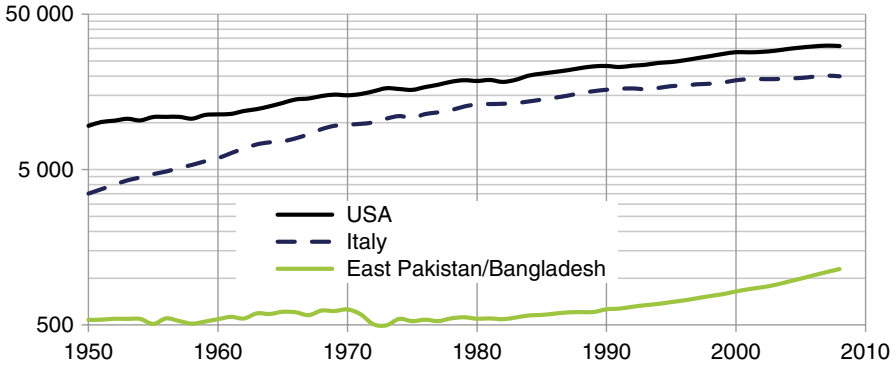

Fig. B.5 Per capita GDP dynamics in the USA, Italy, and East Pakistan/Bangladesh in 1950–2008, international $ 1990 at PPP. *Data source*: Maddison (2001) and (2010)

easier than this was possible in South Europe—hence, during those decades capitals (and technologies) preferred to move to South Europe rather than to South Asia (and the economic growth rates in South Europe were much higher than in South Europe). On the other hand, by the 2000s the gap in the incomes between South Europe and the most advanced Western economies had shrunk in a very substantial way, remaining still very wide as regards South Asia[6] (see Fig. B.5), whereas the human capital had developed in South Asia by that time in a rather dramatic way (see Figs. 3.3 and 3.4). Hence, it is not surprising that in the 2000s South Asia grew much faster than the World System core in general, and South Europe in particular[7] (see Fig. B.5).

Hence the gap between *Sc* and *Sp* continues to grow (the Great Divergence) until the human capital development level of the periphery (*Lp*) reaches a certain level after which the Great Convergence starts. Equation (B.4) seems to be the most parsimonious way to describe mathematically the abovementioned pattern of the Great Divergence and Great Convergence.

The model also accounts for the factor of resource limitations and fundamental limitations (see Акаев 2010).

It should be noted that the accuracy of the mathematical description of the World System macrodynamics regarded by the model significantly increases (especially for the latest decades) if the model accounts for a 25 to 30-year-long lag between literacy growth and the acceleration of economic growth rates. This is not surprising, as the databases that we used (first of all, ones affiliated with UNESCO) commonly regard literacy rate as the proportion of literate population aged 15+. That is

[6] And—of course—the other Third World regions.

[7] Note that the highest values of the convergence force are observed when a large value of $\frac{S_c - S_p}{S_c + S_p}$ is accompanied by a very high level of the human capital development—this was just the case of China in the recent decades.

why literacy level growth (which has lately been proceeding almost only in the Third World countries) occurs each year due to the increase in the proportion of literate 15-year-olds (thanks to the gradual increase of primary education enrollment rate).

However, the growth of the proportion of literate 15-year-olds does not lead to any significant increase of economy growth rates, as even in modern developing countries the majority of literate 15-year-olds do not get involved into manufacturing, but continue their education (even if they start working in manufacturing, they are likely to get only low-qualified jobs where their literacy does not lead to any remarkable productivity growth). The effect of literacy rate growth within this given age cohort is likely to reveal itself only in 25–30 years when the representatives of this age cohort achieve the maximum level of their professional qualification.

Thus, the following lags were introduced into the model: 30 years between the literacy growth and the corresponding GDP per capita growth, and 10 years between the literacy growth and the corresponding slowdown of the population growth rates.

Since the late nineteenth century Kondratieff waves have been clearly observed in time series, especially for economy growth rates (see, e.g., Kondratieff 1926, 1935, 1984; Schumpeter 1939; Rostow 1975; Mensch 1979; Forrester 1981; van Duijn 1983; Marchetti 1986; Freeman 1987; Goldstein 1988; Berry 1991; Hirooka 2006; Tausch 2006; Papenhausen 2008; Korotayev and Tsirel 2010; Korotayev et al. 2011d; Modelski 2012; Thompson 2012; Perez 2012; Grinin et al. 2012; Korotayev and Grinin 2012a; Гринин and Коротаев 2012). Thus, Kondratieff behavior with a 40 to 60-year-long period was externally introduced into the model. In the wave dynamics downswing phases are 1929–1947 and 1973–1987, while upswing phases are 1895–1929, 1947–1973, and 1987–2008.

The following equations are proposed for the formalization of what has been said above. Let

N_c be population in the core, thousands
S_c be "surplus" GDP per capita in the core
L_c be literacy rate in the core
N_p be population in the periphery, thousands
S_p be "surplus" GDP per capita in the periphery
L_p be literacy rate in the periphery

and the system of equation looks as follows:

$$\begin{cases} \dfrac{dN_c(t)}{dt} = a_c N_c(t) S_c(t)\left(1 - L_c(t-10)\right) + \alpha N_p(t) C(t) \\ \dfrac{dS_c(t)}{dt} = b_c S_c(t) L_c(t-30)\left(1 - \dfrac{G(t)}{G_{\text{lim}}}\right) K(t) \\ \dfrac{dL_c(t)}{dt} = c_c L_c(t) S_c(t)\left(1 - L_c(t)\right) K(t) \end{cases} \quad \text{(B.5–B.7)}$$

$$\begin{cases} \dfrac{dN_p(t)}{dt} = a_p N_p(t) S_p(t)\left(1 - L_p(t-10)\right) \\ \dfrac{dS_p(t)}{dt} = b_p S_p(t) L_p(t-30)\left(1 - \dfrac{G(t)}{G_{\text{lim}}}\right) K(t) + \beta S_c(t) C(t) \\ \dfrac{dL_p(t)}{dt} = c_p L_p(t) S_p(t)\left(1 - L_p(t)\right) K(t) + \gamma L_c(t) C(t) \end{cases} \quad \text{(B.8–B.10)}$$

$G = N_c S_c + N_p S_p$	Global GDP, $ thousands[a]
$C = \dfrac{S_c - S_p}{S_c + S_p} \cdot L_p$	"convergence coefficient" describes the interaction of the two components of the system
G_{lim} = 400 trillion dollars	Fundamental limitation
$K(t)$	Kondratieff dynamics

[a]Following Angus Maddison (2001, 2010) calculations here and below are made in international $ 1990, PPP

Thus, for each of the two macro-zones the dynamics of three sub-systems are modeled:

- population, Eq. (B.5) for the core, and Eq. (B.8) for the periphery;
- technological-economic sub-system, Eq. (B.6) for the core, and Eq. (B.9) for the periphery;
- education-cultural subsystem, Eq. (B.7) for the core, and Eq. (B.10) for the periphery.

Table B.2 states the values of equations' coefficients and initial values of the variables N, S, and L (for 1800):

The component $\alpha N_p C$ describes the migration from the periphery to the core, while the migration from the core to the periphery is negligible. We suppose that the volume of migration is proportionate to the periphery literacy rate and to GDP per capita discrepancy between the core and the periphery (as it is mostly literate people in search for better lives who migrate).

The component $\beta S_c C$ describes the diffusion of capital and technology to the periphery. We suppose that both capital and technology start flowing actively only at a sufficient literacy level of the interacting regions (this is why C is

Table B.2 Values of equations' coefficients and initial values of basic variables

Core				Periphery				"Convergence coefficient"	
a_c	2.1×10^{-5}	N_c	1.6×10^{5}	a_p	3.3×10^{-5}	N_p	9.0×10^{5}	α	4.0×10^{-4}
b_c	2.7×10^{-2}	S_c	580	b_p	3.7×10^{-2}	S_p	120	β	4.0×10^{-3}
c_c	1.4×10^{-5}	L_c	0.42	c_p	5.0×10^{-6}	L_p	0.10	γ	1.0×10^{-8}

included into L_p), as well as with a sufficient GDP per capita discrepancy S between the regions.

The component γLN_pC describes literacy diffusion to the periphery.

The second equations of the system (dynamics of S) are to be regarded separately. Taagepera-Kremer-Tsirel-Jones equation looks like

$$\frac{dT}{dt} = bNT.$$

It describes the dynamics of technology development. Taagepera (1976, 1979, 2014), Kremer (1993), Tsirel (2004), and Jones (2005) suppose that the relative technology growth rates are proportionate to population number: the more people, the more potential inventors. It should be accounted here that Taagepera, Kremer, Tsirel, and Jones imply summing the innovation, i.e., not only that a larger number of people do produce more innovations, but they produce more complementary innovations, not repeating ones. This is possible only if the mass of people represents a coherent system. Taagepera, Kremer, Tsirel, and Jones regarded the equation for the World System and stated that it would not work for its separate parts (see also Korotayev 2005, 2007, 2008, 2009, 2012; Korotayev et al. 2006a, b; Korotayev and Khaltourina 2006; Khaltourina and Korotayev 2007).

Indeed, as we have seen above, the periphery having a much larger population did not produce a larger number of innovations than the core. Among other circumstances it was connected with the fact that the periphery did not represent a holistic system, and did not "sum up" its inventions: the innovations made in Africa did not contribute to the innovations in Latin America, neither did they improve the living standards in South Asia.

With regard to this we proposed an alternative equation for technology growth which in our model is associated with S:

$$\frac{dS}{dt} = bSL.$$

The growth rates of technology and GDP per capita are proportionate to literacy rate. Thus, we suppose that namely literacy provides for the additivity of innovations.

From the point of view of the basic one-component model of the World System development, replacing N for L does not "spoil" the dynamics, because, as we have seen above, N is proportionate to L almost in the whole diapason of the demographic transition (see Korotayev et al. 2006a, b for more details).

Retrospective Numerical Calculation from 1800 till the 2000s

Figure B.6 presents the results of quantitative calculation for the period from 1800 till the 2000s:

Figure B.7 describes the dynamics of the difference between the core and the periphery as regards per capita GDP. Figure B.8 presents economic growth rates of the core and the periphery.

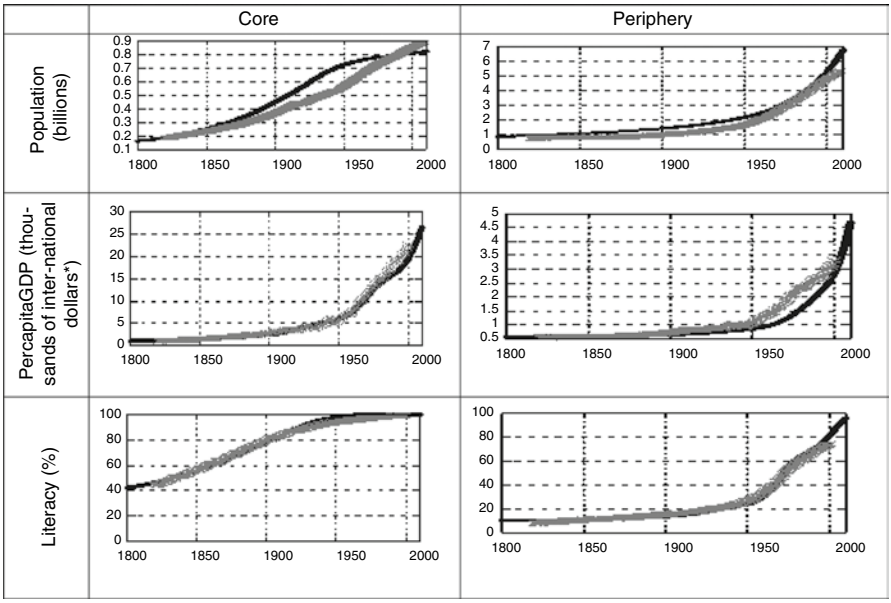

Fig. B.6 Parameters of order. Empirical and theoretical curves. *Note*: Constant international $ 1990, PPP. Here and below *black curves* stand for the calculation, while *grey marks* represent historical data

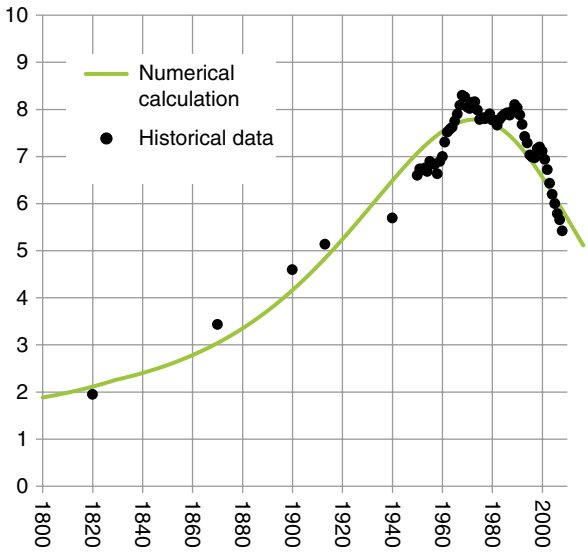

Fig. B.7 Difference between the core and the periphery with respect to per capita GDP. *Note*: the figures on the *Y*-axis scale denote by how many times the GDP per capita in the developed countries exceeded that in the developing countries for a given year. Thus, the value of 7 for 1960 means that in 1960 the GDP per capita was in the developed countries seven times as high as in the developing countries. *Source* of historical data: Maddison (2010)

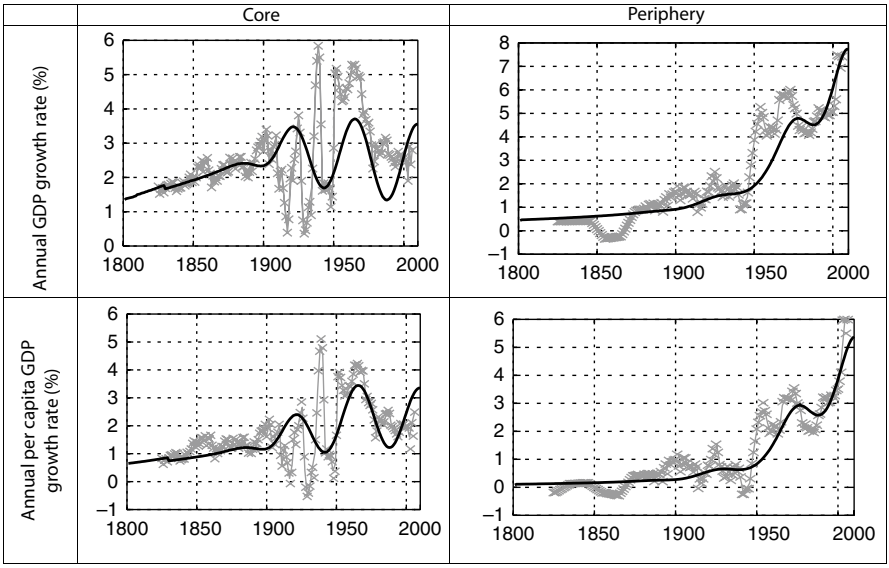

Fig. B.8 Indicators of economic growth rates. Empirical and theoretical curves

Forecast

The model check on the basis of historical data shows that it describes rather accurately the main trends connecting such key variables of the global dynamics as the world population, GDP, and education. This result allows us to use the model not only in retrospective, but also for forecasting as well. The forecast horizon was chosen as half a century, as this is the characteristic time scale for the variables specified. The results of the calculations made according to the model allow making the following forecast (see Figs. B.9 and B.10).

The diagrams suggest that the Great Convergence process will continue in the forthcoming decades, though its rate will experience a certain slowdown.[8]

One of the most important results of the proposed forecast looks as follows. Our inertial[9] population forecast exceeded significantly the UN medium

[8] In the real world this may be connected with the prospect of the "Reindustrialization of the West", on the one hand, and the "middle income trap" threatening the development of many middle-income countries, on the other. As defined by Aiyar et al., the "middle-income trap" is "the phenomenon of hitherto rapidly growing economies stagnating at middle-income levels and failing to graduate into the ranks of high-income countries" (Aiyar et al. 2013: 3). For a detailed description of the factors and mechanisms of the middle income trap see, e.g., Kharas and Kohli (2011). In general the model predicts the slow-down of the Great Convergence speed with the decrease of the gap between the First and the Third World in the forthcoming decades.

[9] The inertial forecasts were generated by the mathematical model (4)–(9) with those values of parameters that produced the best fit with the empirical data for the last two centuries.

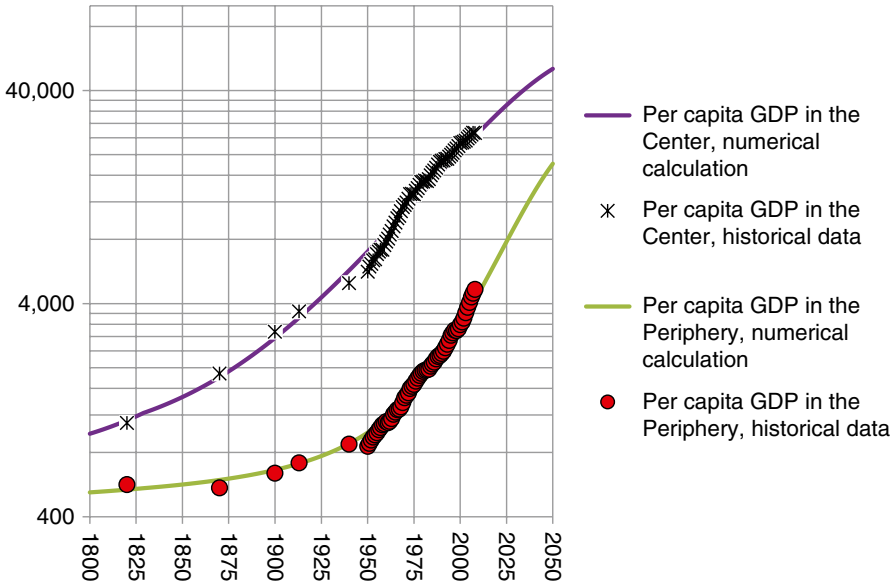

Fig. B.9 Per capita GDP. Forecast till 2050. *Note*: Constant international $ 1990, PPP. *Data source*: Maddison (2010)

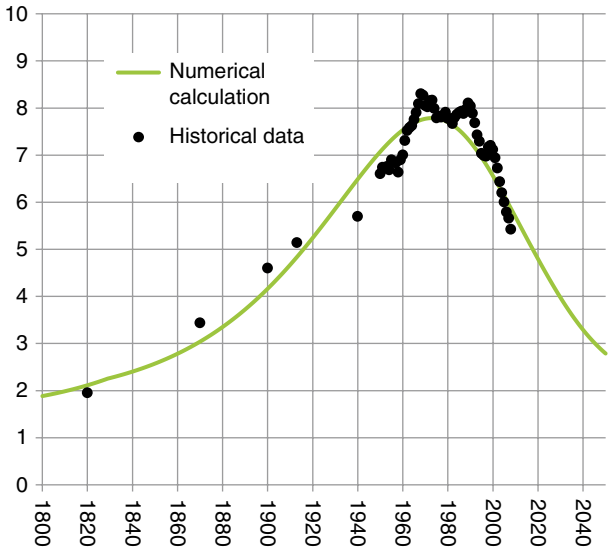

Fig. B.10 Difference between the core and the periphery with respect to per capita GDP. Forecast till 2050

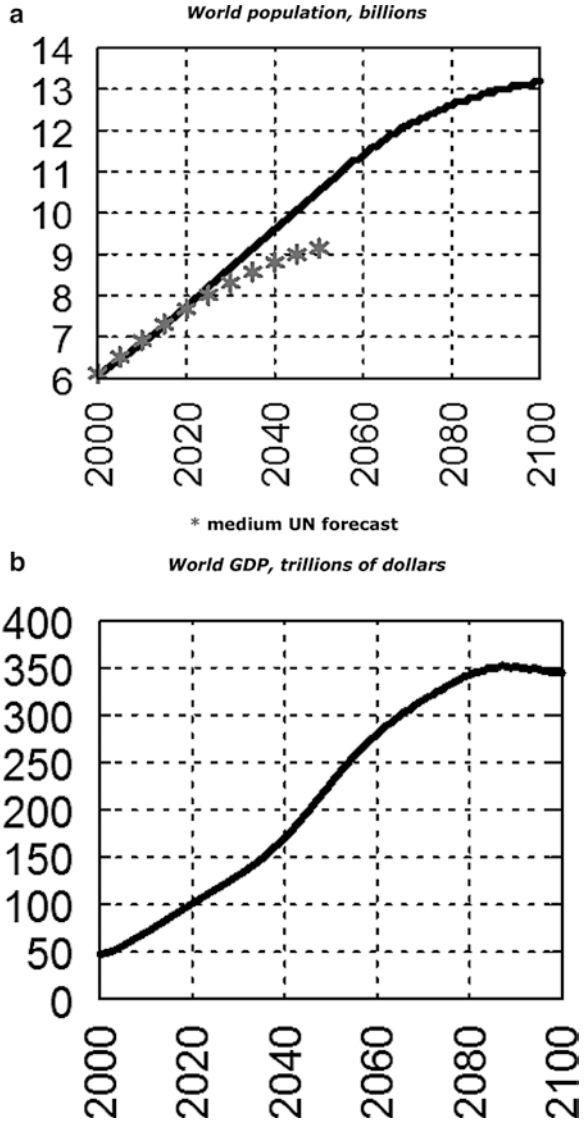

Fig. B.11 World population and GDP. Inertial scenario. Forecast up to 2100. (**a**) World population, billions, *Asterisk* medium UN forecast. (**b**) World GDP, trillions of dollars

population forecast (marked by grey asterisks in Figs. B.11 and B.12). This forecast indicates that within the inertial development scenario the World System will significantly exceed the Earth's carrying capacity in the second half of our century, which can lead to catastrophic consequences (see Fig. B.12). Our further research has made it possible to identify the zone of the risk of such sociodemographic catastrophes in Tropical Africa (see Зинькина and Коротаев 2013; Zinkina and Korotayev 2014).

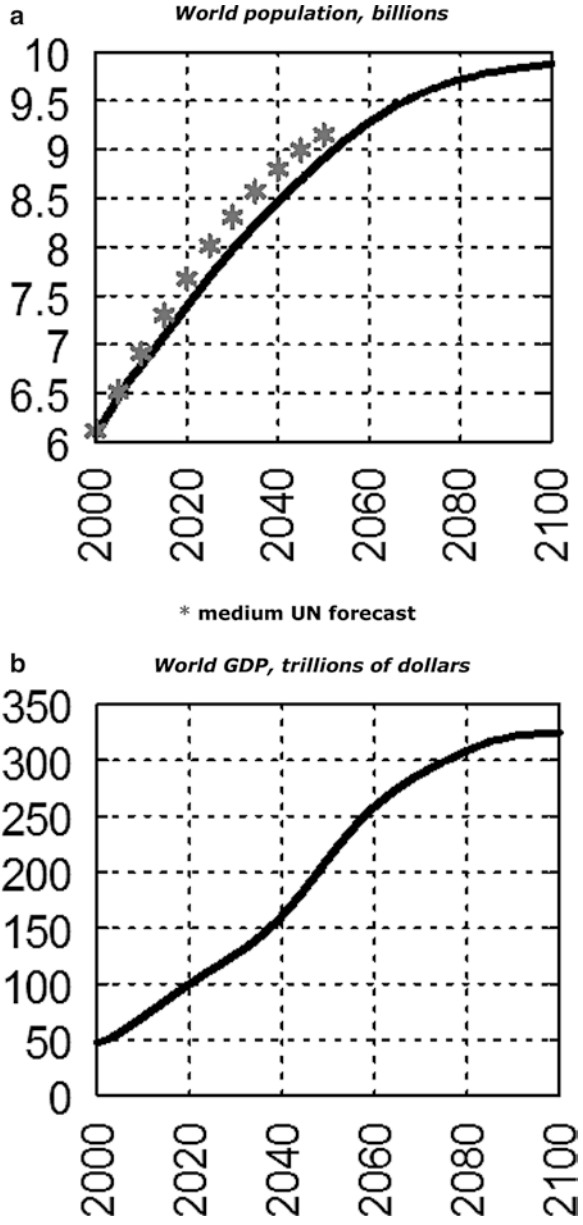

Fig. B.12 World population and GDP. Sustainable development scenario. Forecast up to 2100. (**a**) World population, billions, *Asterisk* medium UN forecast. (**b**) World GDP, trillions of dollars

Interestingly, the sustainable development scenario is possible only at radical increase of the core's support for the peripheral educational programs (especially in Tropical Africa). In the calculations, whose results are shown in Fig. B.12, the value of the coefficient "responsible" for education diffusion (γ coefficient in Eq. (9) above) was increased twice in comparison with the value characteristic for the current time.

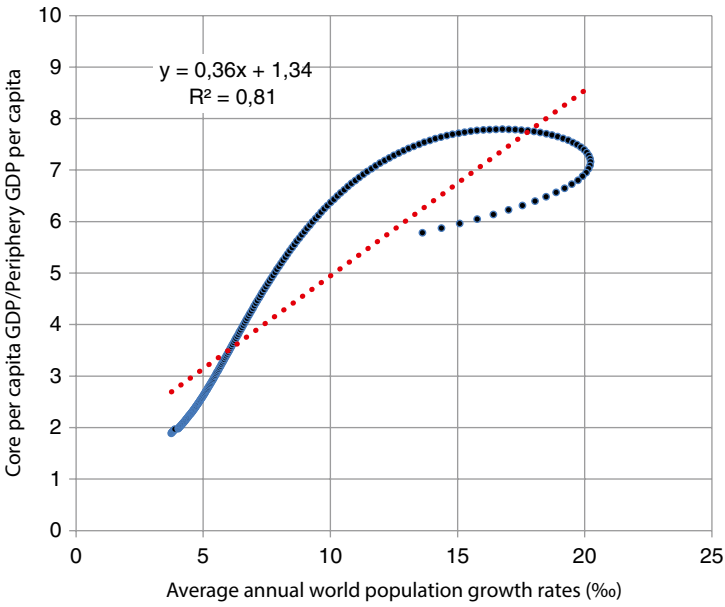

Fig. B.13 Correlation between the gap in GDP per capita between the developed and developing countries and the growth rate of world population (‰)

Note also that the model suggests that we should expect a rather high correlation between the gap in GDP per capita between the First and Third World, on the one hand, and the growth rates of world population, on the other (see Fig. B.13).

This hypothesis will be tested in the next section.

The Phases of Global Demographic Transition as Correlated with Phases of the Great Divergence and Great Convergence[10]

The mathematical model described in the previous section suggests that we should expect a rather high correlation between the gap in GDP per capita between the First and Third World, on the one hand, and the growth rates of world population, on the other. To start testing this hypothesis, consider the general dynamics of the gap in GDP per capita, shown as the ratio between the GDP/capita in the First and Third Worlds from AD 1 to 2008 (see Fig. B.14a).

The curve shown in Fig. B.14a displays a rather close similarity to the curve of the world's population growth rate (shown here as the annual increase per thousand)

[10] This section has been prepared on the basis of our article "Phases of global demographic transition correlate with phases of the Great Divergence and Great Convergence" (Korotayev et al. 2015).

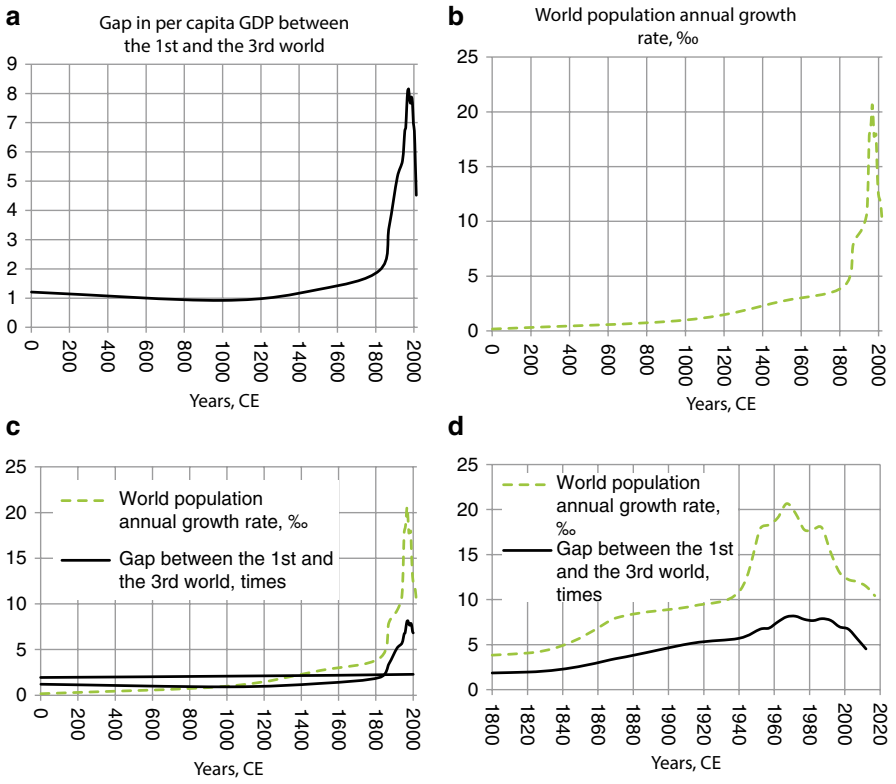

Fig. B.14 Dynamics of the gap in GDP per capita and annual world population growth rates. *Note*: In (**a**) the figures on the *Y*-axis denote by how many times the average GDP per capita in the First World countries exceeded that in the Third World countries for a given year. Thus, the value of 7 for 2000 means that in 2000 the GDP per capita was seven times higher in the First World states than in the Third World countries. In (**b**) the *Y*-axis gives the global population growth rate in annual increase per thousand. Until 1940, the world population growth rate curve depicts the trend line and does not take into account cyclical and stochastic fluctuations

presented in Fig. B.14b. This similarity becomes especially salient when both curves are plotted in the same graph (Figs. B.14c, d), and persists when looking at the full span of two millennia or only at the two most recent centuries.

Regression analysis indicates that the correlation between the relative growth rates of the world population and the GDP per capita gap between the First and Third World has a remarkably high value (see Fig. B.15).

We are dealing here with a very tight correlation, accounting for 92 % of all the variation. In fact, it is even higher than the correlation generated by our mathematical model (see Fig. B.13). The match between the dynamics of world population growth, on the one hand, and the dynamics of the gap between the First and the Third World GDP per capita, on the other, looks especially salient in Fig. B.16, where a logarithmic scale is used to facilitate the comparison across different scales.

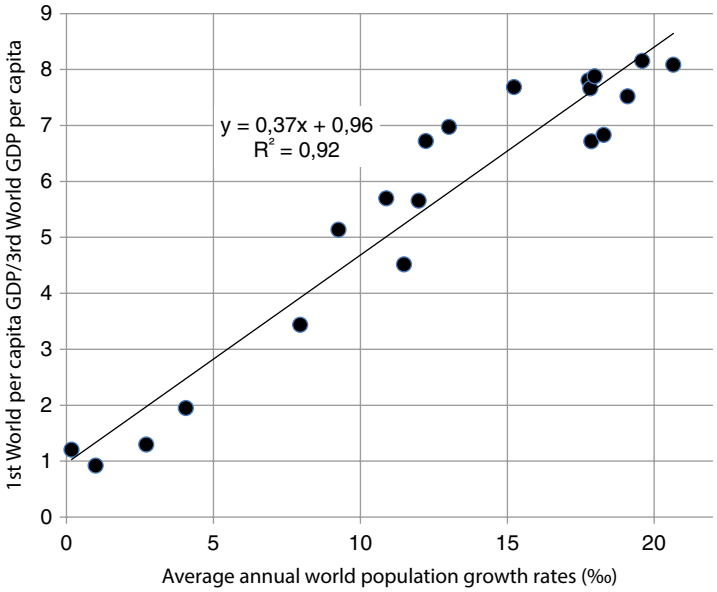

Fig. B.15 Correlation between the gap in GDP per capita between the First and Third World and the growth rate of world population (‰). *Note*: Data in Methods and data summary for this appendix

The high correlation of the two time series is apparent. The significant acceleration of the world population growth rate observed in the nineteenth century (from 4.1 ‰ per year *c.* 1820 to 7.95 ‰ by 1870) corresponds to an explosively accelerated widening of the per capita income gap between the First and Third World. During the period of 1870–1940 the deceleration of world population growth corresponded to a certain slowdown in the pace of the Great Divergence. Then, following the Second World War, a surge of acceleration of world population growth took place; and, as expected, it coincided with a renewed, corresponding acceleration of the global Divergence. Even a certain hitch in the acceleration of the world population growth rates that was observed in the 1950s was accompanied by a certain hitch in the Divergence speed. Both the gap between the First and Third World GDP per capita and the relative world population growth rate reached their peaks almost simultaneously (at 8.1 times for the gap and a rate of 20.65 ‰ per year for world population growth) in the late 1960s. There followed a decade in which the values of both variables declined, commencing the Great Convergence. However, in the late 1970s and early 1980s both the slowing-down of the world's population growth rate and the decrease of the per capita income gap were interrupted (almost simultaneously). One could observe, throughout most of the 1980s, certain proportional, and mostly simultaneous, increases in both the per capita income divergence between the First and the Third World, and the world population growth rate. Then

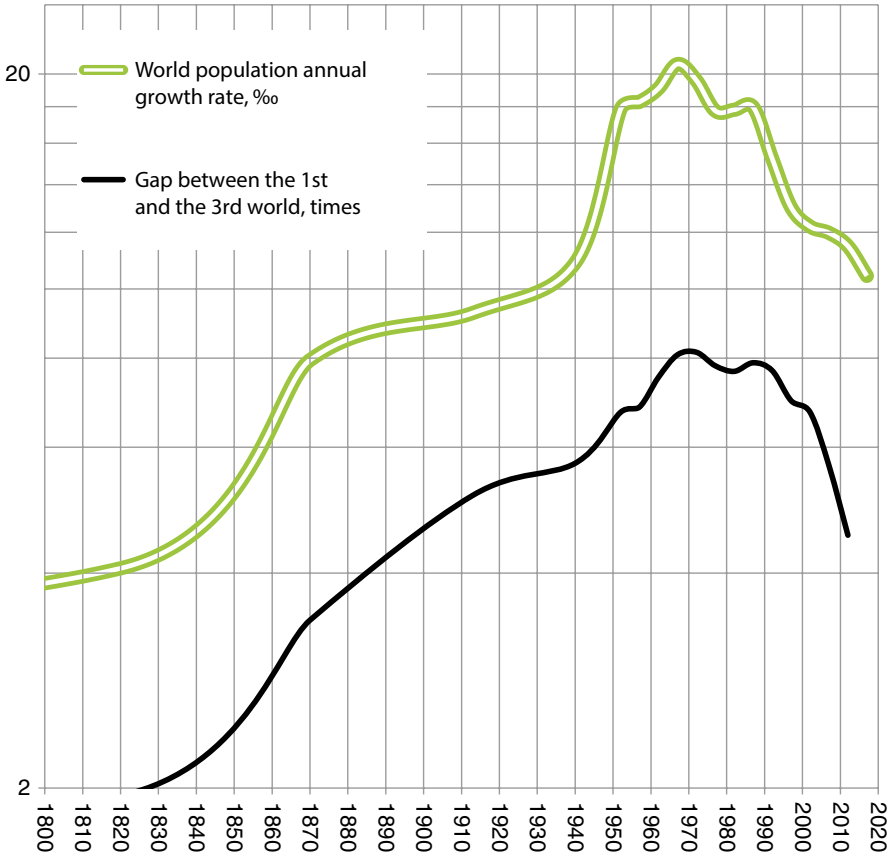

Fig. B.16 The gap in GDP per capita between the First and the Third World, 1–2008 and the growth rate of world population (‰), logarithmic scale

in the late 1980s there began a sharp and mostly steady (though not without certain hitches) decrease of both the GDP gap and the world population growth rate that has continued to the present day.

The Income Gap and World Population Growth as Tightly-Coupled Processes

It could not be entirely ruled out, of course, that at least some of the consistency in this picture may be attributable to coincidence. However, as is suggested by the mathematical model presented in the previous appendix, the existence of a high correlation between the two time series can be explained. In truth, both of the global

processes (the global demographic transition, otherwise known as the global demographic modernization, on the one hand, and the Great Divergence turning into the Great Convergence, on the other) ought to be viewed as interrelated and showing two sides of one phase transition in the development of the World System—the global modernization.

As is described by the mathematical model in the present appendix, and as is confirmed by the empirical data, the explosive acceleration of the Great Divergence in the nineteenth century was quite naturally accompanied by a significant acceleration of the world population growth rate. The economic and technological modernization of the West, which propelled it to global leadership in labor productivity and per capita income, was then the major factor that determined the scope of divergence (e.g., Mokyr 1990b; Goldstone 2002, 2008b; Clark 2007; Allen 2009, 2011). At the same time, these positive developments in the West led to substantial improvements in the production, harvesting, storage, and transportation of food, and gains in public health and sanitation, resulting in increasing life expectancies and significantly declining mortality rates across all industrializing countries. In other words, the vast economic improvements brought about by the Industrial Revolution advanced the Western countries to the first phase of the demographic transition (e.g., Chesnais 1992; Caldwell et al. 2006; Dyson 2010; Reher 2011). In this phase, lasting throughout most of the nineteenth century in the industrializing countries, mortality declined sharply while fertility remained at a high level (e.g., Caldwell et al. 2006; Gould 2009; Dyson 2010; Reher 2011; Livi-Bacci 2012). It resulted in a rapid acceleration of population growth in the countries of the West, which was a very important factor in the acceleration of world population growth rates in the nineteenth century (Gould 2009; Dyson 2010; Reher 2011; Livi-Bacci 2012).

From 1870 to 1920, most industrialized countries entered the second phase of the demographic transition, in which fertility began to decline and population growth slowed. This decelerated the growth of world population. The gap in GDP between the First and Third worlds continued to grow, but more slowly. While in the First World slowing population growth and continued economic development led to ever-higher per capita GDP, the Third World also began to benefit from the rapid growth in international trade and the diffusion of railroads and international investment.

In the period after the Second World War, the acceleration of world population growth and the increase in the speed of Divergence were also rather strongly interconnected. At this later phase of global modernization, the main contribution to the acceleration of world population growth was made by the entrance of the majority of the Third World countries (where the overwhelming majority of the world population lived) into the first phase of the demographic transition (e.g., Caldwell et al. 2006; Gould 2009; Dyson 2010; Reher 2011; Livi-Bacci 2012). It is of note that in most cases their entrance was not primary (i.e., connected to radical increases of their economic growth rates, as was observed in the Western countries during the prior period), but rather secondary. That is, it arose from the diffusion of healthcare technologies that caused a very rapid decline in infant and child mortality (from 350+ ‰ to 35 ‰ or less). The drop in mortality associated with the Third World's first phase of the demographic transition was therefore even more rapid than that

which occurred in the First World; combined with still high fertility it resulted in a dramatic acceleration of world population growth.

The resulting population growth in the Third World was more rapid than any seen in the world history; the growth rates of 30 ‰ or even 40 ‰ pushed world population growth rates to new highs. However, such rapid growth rates also held down the growth of per capita incomes in developing countries relative to the rapid gains being made in the First World in the decades after WWII (even though the First World also experienced a brief surge in population growth rates after the War). It was only when the Third World countries also began to limit fertility, entering their second phase of the demographic transition that their per capita GDP growth sharply accelerated to levels above those of the First World. With this transition, world population growth rates began to drop sharply, as did the income gap; we have since been seeing the Great Convergence.

The crucial role of population dynamics in driving GDP/capita in this phase can be seen in the fact that overall GDP growth rates in the Third World were already roughly as high as those in the First World in the 1950s and 1960s, as shown in Fig. B.17. However, in the Third World this growth arose against the background of a demographic explosion [that is very characteristic for the first phase of the demographic transition (see, e.g., Chesnais 1992; Caldwell et al. 2006; Dyson 2010; Reher 2011; Livi-Bacci 2012)], whereas by then the First World countries were in the second phase of the demographic transition and were experiencing a slower population growth. From 1950 to 1970 the population of the Third World countries increased by 56 %, more than twice as much as that of the First World countries, which grew only by 24 % in this period. As a result, during the 1950s and 1960s the gap between the First and Third World in per capita GDP increased substantially despite the fact that overall GDP growth in the developed and developing countries was almost identical in those years.

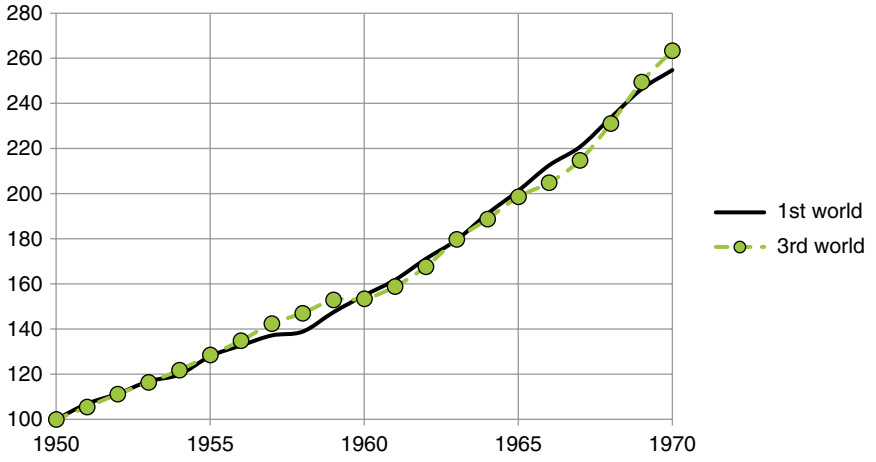

Fig. B.17 Relative GDP dynamics of the First and Third World 1950–1970, 100 = 1950 level

Hence, the close coupling between economic and demographic dynamics in both of these phases of global modernization is clear. However, it differed rather significantly as regards its contents and direction across the periods. In the West of the nineteenth century it was per capita GDP that served as the main independent variable whose growth then led to the decrease of mortality and the acceleration of the population growth, whereas in the postwar Third World it was the population growth rate that led; the initial acceleration of population growth initially held back per capita GDP growth, but the deceleration of population growth then produced a demographic dividend (more workers and fewer dependents) that helped produce much higher GDP growth rates.

Figure B.18 demonstrates how closely the economic and demographic dynamics were linked. The peak of the gap in GDP per capita in the late 1960s also coincided with the absolute minimum in the share of the working-age population in the total population in the Third World countries (UN Population Division 2014). It was precisely when the impact of falling fertility started to produce a rising percentage of workers—the "demographic dividend"—in developing nations (e.g., Bloom et al. 2001; Bloom and Sevilla 2002; Mason 2001, 2007; Hawksworth and Cookson 2008: 7–10) that the income gap with the First World started to decline (see Fig. B.18).

Therefore, we can argue that the peak in the income gap between the First and Third World occurring with almost perfect accuracy at the same time as the peak in world population growth rates is no coincidence. It is because the onset of the great Convergence depended on a slow-down in growth rates in the Third World that decelerated world population growth. Indeed, throughout the modern era the gap between First and Third world incomes has been determined mainly by the timing of their entry into the first and second phases of the demographic transition.

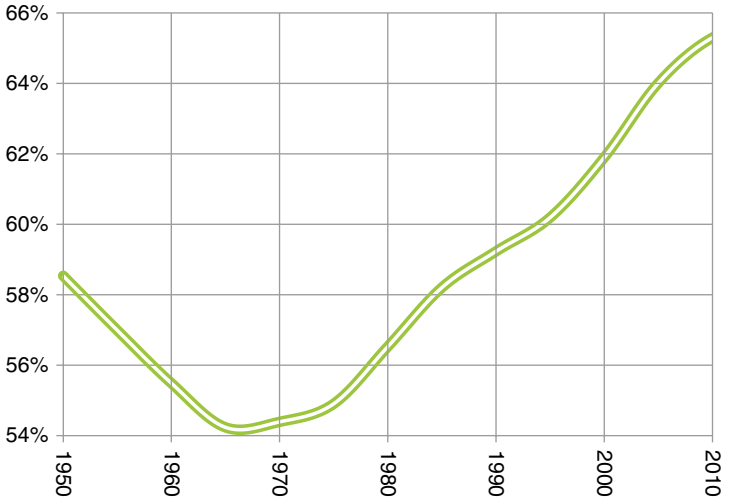

Fig. B.18 Dynamics of the percentage of the working age population (15–65 years old) in the total population of the Third World countries, 1950–2010

We can hardly say that the dynamics of the Great Divergence and Great Convergence are determined entirely by the dynamics of the global demographic transition. The onset of the modernization process, including the reorganization of politics, the economy, and social life, was due to many factors (see, e.g., Mokyr 1990b; Barro 1991; Sachs et al. 1995a, b; Sala-i-Martin 1996; Quah 1996c; Lee et al. 1997; Pomeranz 2000; Yifu Lin 2003; Allen 2009, 2011; Clark 2007; Korotayev et al. 2011a, b, c, d; Spence 2011; Goldstone 2002, 2008b, 2012b). However, we are quite ready to claim that, once begun, the impact of modernization on incomes was strongly dependent on the timing of the phases of the demographic transition in different regions. The dynamics of global population growth and the Great Divergence and Great Convergence therefore may be considered so closely coupled as to be two sides of the same coin.

Methods and Data Summary for Appendix B

GDP and population data were obtained from Maddison (2010) and the World Bank's *World Development Indicators* Database (World Bank 2014). First World countries comprised 30 Western European Countries, the USA, Canada, Australia, New Zealand, and Japan. GDP was totaled across these countries, and divided by total population to obtain First World GDP per capita. We designated as Second World countries the USSR, Yugoslavia and their successor republics, and five eastern European countries. The Third World population and GDP were obtained by subtracting the sum of First World and Second World GDP and population from the World totals. Full specification of the country lists for First and Second worlds is given below. The data was taken for the following years, to span the entire period 1–2012AD, at points spaced to capture the movements of GDP/capita: AD 1, 1000, 1500, 1820, 1870, 1913, 1940, 1952, then every 5 years up through 2012.

The Gross Domestic Product (GDP) per capita is a widely used national accounting measure of economic prosperity. The World Bank defines it as "the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources" (World Bank 2014). We obtained the long-term data (from 1 up to 2008 AD) on the GDP dynamics (in 1990 International Geary–Khamis dollars at purchasing power parity) from Angus Maddison's database (Maddison 2010). For the period after 2008 the data have been obtained from the *World Development Indicators* Database (World Bank 2014).

To secure the compatibility of data, the World Bank GDP data have been recalculated in accordance with Maddison's coefficients of conversion of current US dollars into international dollars at purchasing power parity. The following countries from Maddison's country list have been identified as the "First World countries": 30 Western European countries (Austria, Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Norway, Sweden, Switzerland, UK, Ireland, Greece,

Portugal, Spain + 14 small Western European countries, for which Maddison only provides summary estimates of their GDP and population), 4 "West European offshoots" (Australia, New Zealand, Canada, USA), and Japan. The GDP values for the First World for particular years were calculated by summing up Maddison's GDP estimates for each of the 16 Western European countries, 4 Western European offshoots, Japan, and the summary estimate for the 14 small Western European countries. We applied a similar procedure to obtain the population numbers for the First World. The First World GDP per capita for each year in the time series results from dividing the year's total GDP of the First World countries into their total population that year. Computations of the Second World's GDP, population, and GDP per capita have been conducted similarly. We put these former Eastern Bloc countries in the "Second World" category: former constituent republics of the Soviet Union, Czechoslovakia, and Yugoslavia + Albania, Bulgaria, Hungary, Poland, and Romania. We calculated the "Third World" GDP by subtracting the First and Second World GDP from the world GDP. The Third World population figures were produced the same way. We calculated the Third World GDP per capita for each year in the series by dividing the total GDP of the Third World into its total population for the given year.

We obtained the population data from Angus Maddison's database (Maddison 2010). We decided to use this database because Angus Maddison provides population estimates precisely for the time-points and countries for which he provides his GDP figures. Hence, this is the only database that allows us to calculate the long-term dynamic estimates of the per capita income gap between the First and Third World. We opted to use the UN Population Division (UN Department of economic and social affairs, Population Division 2014) data for the world population relative growth rate past 1950 (no estimates for the earlier period are available there). The UN Population Division provides its estimates for the world population annual growth rates for 5-year intervals (for example, for the period of 1950–1955 it states the average annual estimate for this period of 1.786 % per year). For comparison, we used mid data points as regards the values for the gap between the First and Third World.

As we are interested in the correlation between phases of global demographic transition and phases of Great Divergence and Great Convergence, Figs. B.14, B.15, B.16 and B.17 for the period before 1940 display the trend line only, omitting those data points that reflect cyclical and stochastic fluctuations (specifically, the data points for the years 1600, 1700 and 1900). Thus, the following dataset has been used to construct Figs. B.14, B.15, B.16 and B.17 (see Table B.3).

For years from 1 to1940, figures in Column 2 indicate the average annual world population growth rate in the period starting with the respective year. For example figure 7.95 in row #5, in column #3 (next to 1870) indicates that the average world population relative annual growth rate in 1870–1913 was equal to 7.95 ‰ per year. For years 1952–2017 they indicate the average annual world population growth rate for a respective 5-year period. For example figure 20.65 in row #11, in column #3 (next to 1967) indicates that in 1965–1970 the average world population relative annual growth rate was equal to 20.65 ‰ per year. For years 1–1940 world popula-

Table B.3 Data used for the construction of figures in Appendix B

Row #	Year	World population annual growth rate, ‰	Gap between the first and the third world, times (=first world per capita GDP/third world per capita GDP)
1.	2.	3.	4.
1	1	0.17	1.21
2	1000	0.99	0.92
3	1500	2.71	1.30
4	1820	4.06	1.95
5	1870	7.95	3.44
6	1913	9.25	5.14
7	1940	10.88	5.70
8	1952	17.86	6.72
9	1957	18.28	6.83
10	1962	19.09	7.52
11	1967	20.65	8.09
12	1972	19.59	8.15
13	1977	17.76	7.80
14	1982	17.82	7.67
15	1987	17.97	7.88
16	1992	15.23	7.67
17	1997	13.01	6.97
18	2002	12.23	6.72
19	2007	11.98	5.66
20	2012	11.48	4.52
21	2017	10.43	

tion growth rate estimates have been calculated on the basis of Maddison's estimates for the world population; for years 1950–2010 these are UN Population Division estimates; for years 2010–2020 these are UN Population Division medium projections.

We must note that if we add to the dataset all of Maddison's data points (that is, including the years 1600, 1700, and 1900), the correlation between the global demographic growth rate and the magnitude of the Great Divergence does not become weaker. In fact, it becomes stronger: $r^2 = 0.93$. Thus, the exceptional cyclic or stochastic fluctuations in GDP in these years do not affect the overall relationship between the income gap and the rate of global population growth.

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