Advances in Economics of Information Systems

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Dedication

For my mother, my father,
my sister, and Miki

Advances in the Economics of Information Systems

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Preface

Technological advances, primarily in the use of Internet and mobile technologies, combined with the deregulation of the communication market created a new and highly competitive environment for companies globally. Although technology is the driver of the changes, economics plays a major role in this new environment. The recent dot.com boom and bust is a great example of this relationship.

However shocking the NASDAQ crash was to some, as Brad deLong (2001) suggests:

> *… the long-run economic impact of the 'new economy' is likely to be very large indeed for two reasons. First, the pace of technological progress in the leading sectors driving the 'new economy' is very rapid indeed, and will continue to be very rapid for the foreseeable future. Second, the computers, switches, cables, and programs that are the products of today's leading sectors are general-purpose technologies, hence demand for them is likely to be extremely elastic. … Over a wide range, the dominant effect of the 'new economy' has been to make competition more effective, not to create scale-related cost advantages. Third, the principal effects of the 'new economy' are more likely to be 'microeconomic' than 'macroeconomic.'…*

By addressing issues in the intersection of technology and economics, economics of information systems area strives to further our knowledge on how information technology can create value for businesses and consumers alike.

This book will introduce readers to the underlying economic aspects of information technology. It is one of the few that brings together different trends of research in this young field. It covers concepts that complement or even challenge traditional economic theories while contributing to the research in information systems.

Organization of the Book

The book is organized into 10 chapters. A brief description of each of the chapters follows:

In Chapter I the authors study the standards competition between DIVX and DVD formats. In April 1997, a consortium of hardware manufacturers and movie studios launched the DVD format. By that fall, electronics retailing giant Circuit City announced its intention to launch a partially incompatible format known as DIVX. The chapter assesses Circuit City's strategy to establish the dominant standard for digital video technology. It identifies several key principles that any firm must consider when deciding how to compete in a market with evolving standards. The authors argue that virtually all of these factors weighed in against Circuit City, so that its effort was destined to fail.

Chapter II explores the private and social desirability of information transparency of a business-to-business (B2B) exchange that provides an online platform for information transmission. The abundance of transaction data available on the Internet tends to make information more transparent in B2B electronic markets. In such a transparent environment, it becomes easier for firms to obtain information that may allow them to infer their rivals' costs than in a traditional, opaque market. How then does this benefit firms participating in the B2B exchanges? To what extent does information transparency affect consumers and the social welfare in a broader sense? Focusing on the *informational* effects, this chapter explores firms' incentives to join a B2B exchange by developing a game-theoretic model under asymmetric information. The authors then examine its effect on expected profits, consumer surplus, and social welfare. The results challenge the "information transparency hypothesis" (that is, open sharing of information in electronic markets is beneficial to all participating firms). In contrast to the popular belief, the chapter shows that information transparency could be a double-edged sword. Although its overall effect on social welfare is positive, its private desirability is deeply

divided between producers and consumers, and even among producers themselves.

In Chapter III the authors explore the evolution of B2B e-market firms in terms of the strategies they employ to "perfect" their value propositions and business processes for the firms. This is a critical aspect of their attractiveness as business partners for the buyers and sellers that participate in their electronic marketplaces. The key theoretical perspectives of this work are adapted from economics and strategic management. They enable the authors to construct a "partnering for perfection" theory of strategic alliances in e-procurement markets. This perspective is captured in a series of inquiries about "why" and "when" B2B e-markets are observed to form alliances. The authors carry out an innovative econometric analysis that delivers empirical results to show the efficacy of the theory in interpreting real-world events. The chapter concludes with a discussion of the implications of this work in academic and managerial terms.

Internet-based selling offers firms many new opportunities regarding the strategies for design of mechanisms to support consumer transactions. Chapter IV examines the use of transparency as a strategy for Internet-based selling for maximizing firms' value from their selling activities on the World Wide Web. The authors define "transparency" as the extent to which a seller reveals private information to the consumer and explore three of its most-often observed dimensions: product, price, and supplier transparency. They evaluate consumers' responses to each kind of transparency in terms of their willingness to pay. The chapter positions the theory in the context of the online air travel (OTA) industry to showcase its applicability and the power of its theoretical insights in an appropriate real-world context. The authors also generalize our findings to suggest some managerial guidelines that will help managers who want to make choices regarding transparency strategy in other Internet-related business contexts.

Chapter V analyzes the structural dynamics of multilateral B2B relationships based on game theoretical approach. It focuses on the evolution of network structures initiated by three major forces: a neutral intermediary, a dominant supply-chain partner, and an industry consortium. The authors show the typical enterprise network structures, identify the conditions that cause structure reconfiguration, and demonstrate the change of social welfare in the evolution process. Web-based technologies have changed the landscape of the entire enterprise networks, and the proposed framework will provide an analytical understanding of the endogenous formation and dynamics of enterprise networks in the information era.

Escrow is an emerging trust service in online consumer-to-consumer auction markets in preventing Internet fraud. Chapter VI studies the effect of traders' perceived risk on the adoption of online escrow service. This research establishes decision-making models for both the honest trader and the monopolist online escrow service provider. Perceived risk rate (PRR), a dynamic measure of perceived risk for online traders, is introduced to link the two decision-making models together. A calculative model for PRR is proposed, and the primary outcomes from the computer simulation for PRR measurement are presented. This chapter reveals that online escrow service (OES) adoption is positively correlated to the estimated level of trader's PRR. A higher PRR definitely leads to a higher OES adoption rate and hence reduces the Internet fraud in the auction markets. In addition, an overestimate of PRR leads to a higher adoption rate, lower defrauding rate and higher fraud blocking rate.

Chapter VII studies the joint effects of inter-firm collaboration and electronic business on firm profitability primarily in Finnish manufacturing. It is found that deeper forms of inter-firm collaboration boost financial performance but that high e-business intensity might even strain profitability. Firms that simultaneously have high inter-firm collaboration and e-business intensities as well as use electronic networks for conducting their collaboration are also more profitable. Based on this, two conclusions are drawn. First, suitable e-business practices facilitate inter-firm collaboration. Once in place, inter-firm collaboration tends to be immensely more productive with supporting electronic means. Second, e-business investment has to be accompanied by complementary organizational innovations, in this case a new form of external (and also internal, although not observed directly in the data used) organization of the firm, that is, inter-firm collaboration.

In Chapter VIII the authors draw on behavioral economics literature to identify the conditions under which consumers would prefer one of three pricing schemes (prepayment, pay-as-you-go, and post-payment). They suggest that consumer preferences for particular pricing schemes are likely to be determined by systematic relationships that exist among a variety of psychological variables. They offer nine empirical propositions that identify when consumers will prefer different pricing schemes.

In Chapter IX the author attempts to build a bridge between mobile commerce and the emerging field of behavioral economics. He first provides examples from mobile commerce and links them to behavioral economics. A stylized model assesses the impact of hyperbolic discounting on the profit maximizing behavior of a monopolist firm. He finds that the monopolist makes

lower profits compared to exponentially discounting consumers for low levels of (positive) network externalities. As the network externalities increase, first-period prices increase, second-period prices decrease, and the profits increase in equilibrium.

The book contributes to the field of economics of information systems by providing a collection of chapters at the forefront of the research in this field. From online auctions to behavioral economics of mobile commerce, the chapters touch upon a variety of novel topics.

References

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May 2004

Chapter I

Surviving a Standards War: Lessons Learned from the Life and Death of DIVX

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Abstract

In April 1997 a consortium of hardware manufacturers and movie studios launched the DVD format. By that fall, electronics retailing giant Circuit City announced its intention to launch a partially incompatible format known as DIVX. This chapter assesses Circuit City's strategy to establish the dominant standard for digital video technology. We identify several key principles that any firm must consider when deciding how to compete in a market with evolving standards. We argue that virtually all of these factors weighed in against Circuit City, so that its effort was destined to fail.

Introduction

Standards are a common feature of many technology-driven industries, from telecommunications to computers, from compact discs to VCRs. During the infancy of these industries, there are often several competing standards. Most of the time, firms and consumers coalesce around a common standard. As an industry evolves towards that standard, each firm has to make a choice: Should it adhere to the same standard used by most other firms, thereby attempting to "compete in the market"? Or should it attempt to impose its own standard, hoping that standard will come to dominate, thereby competing "for the market".

This chapter discusses a recent standards battle in the DVD market. In the context of that battle, we discuss several key principles that managers must consider if they are to make an informed decision about competing over standards. Shapiro and Varian (1999) discuss in detail the assets that assist a firm fighting a standards war, as well as the strategies and tactics to be employed in standards wars. Our chapter in contrast provides a fresh look at some key principles in the context of the DVD versus DIVX standards war.

Despite the fact that Circuit City ended up losing a standards war that it initiated, there are valuable lessons to be learned from the case. Firms that carefully consider and balance the principles we discuss are likely to improve their chances of surviving and winning standards wars.

Literally billions of dollars may rest on whether firms make the right decisions. Sony banked on its Beta format VCR and lost out to JVC's VHS format. But Sony scored a huge success when it partnered with Philips to set the standard in the compact disc market. Nintendo secured a near-monopoly in the video gaming market when its 8-bit gaming system drove Atari from the market. Microsoft hit the biggest jackpot of them all when its DOS operating system won out over Apple's windows-driven operating system.

Visions of such past successes must surely have weighed on the mind of Richard Sharp, CEO of Circuit City, as he contemplated the future of the fledgling market for Digital Versatile Discs (DVD). In April 1997 a consortium of hardware makers and motion picture studios introduced DVD as an affordable, yet markedly superior, replacement for videotapes. Wary of starting a standards war, the DVD consortium had agreed to a common standard. If the format succeeded, all firms throughout the industry would prosper.

As the nation's largest electronics retailer, Circuit City was a critical member of the DVD value chain. But Circuit City was not content to compete in the market. In September 1997 it introduced a competing format called Digital Video Express, or DIVX. In theory, DIVX could do everything that DVD could do and more. If successful, DIVX could replace DVD as the industry standard, and Circuit City would profit from every unit of hardware and software sold throughout the world.

Less than two years after Circuit City made its bold gamble, DIVX was dead. According to a July 1999 online article appearing in Tape Disc Business, Circuit City invested $330 million in DIVX (Reilly, 1999). Circuit City failed because the conditions required for it to win a standards war were not present. Had Circuit City assessed the situation correctly, it might have avoided the costly debacle.

A Detailed History of DVD and DIVX

In the mid-1990s the worldwide video industry was moribund. The basic technology had not changed since the mid-1970s, and penetration and sales of VCR hardware and software were flat. To lift the industry out of its doldrums, the DVD consortium shepherded the development of the new digital format.

By now, most consumers are familiar with DVD. Video and audio information are encoded on a disc that looks exactly like a compact disc. DVDs contain 10 times more information than CDs, however. As a result, DVDs boast video resolution that is more than twice that of the videocassette and five-channel surround sound capability that rivals or exceeds the sound quality of CDs. The DVD consortium had every reason to believe that its superior quality and reasonable cost would enable the DVD to revive the video industry.

Seeking to avoid the VHS-Betamax "format war" that delayed the growth of the videocassette market, the DVD consortium saw to it that the DVD would be an "open format," meaning that all machines would play all DVDs. At the same time, all DVD discs would be encoded with the Dolby Digital sound process, so they would be compatible with virtually all home-theater electronics.

Early adopters responded enthusiastically to the DVD launch. Through August 1997 more than 140,000 players had been shipped to dealers in the U.S., with

an estimated 100,000 sold to consumers. This compares very favorably to the initial sales of compact discs, VCRs, and other home entertainment technologies. Studios found eager consumers for their software. Titles such as *Batman*, *Blade Runner*, and *Das Boot* found their way into 10% or more of all DVD households.

While some studios, notably Warner and Columbia, enthusiastically supported DVD, others held back. Paramount, Fox, Disney's animated motion picture division, and movies directed by Steven Spielberg and George Lucas were the most obvious missing in action. Some of these studios were concerned about the potential for piracy. Studios may also have been waiting for a larger installed base to assure a bigger sales "bounce" when they finally did enter the market.

Early adopters otherwise appeared to be quite optimistic about the new format. It was possible to get a good read on the attitudes of early adopters by reading various Internet DVD forums that emerged during the summer of 1997. Just a few months after the introduction of DVD, the most popular DVD chat sites were receiving more than 2,000 posts weekly. Many posts predicted that the upcoming Christmas season would see the mass-market breakthrough of DVD. This would be unprecedented — no similar technology (for example, VCR, compact disc) had succeeded so quickly.

There were other indications that DVD might be a hit. During the summer of 1997 Internet vendors emerged offering discounted prices on DVD hardware and software. At the same time, Best Buy (the nation's second largest electronics retailer at the time) threw its full support behind the DVD, with special in-store displays, wide selections of hardware and software at discounted prices, and heavy advertising. Perhaps the forecasts of a big DVD Christmas might come true.

Tempering the early enthusiasm for the DVD were occasional rumors about a competing technology known only as "zoom," which was supposed to be a pay-per-view alternative to open DVD. The rumors came true on September 8, 1997, when Circuit City announced its intention to introduce Digital Video Express (DIVX). DIVX was a joint venture between Circuit City and the law firm of Ziffren, Brittenham, Branca & Fischer.

DIVX would be partially compatible with DVD. Specifically, DIVX players would play all DVD discs, but DVD players could not play DIVX discs. DIVX discs were "locked" by an encryption technology that would be unlocked when the user started playing them and remain unlocked for 48 hours. Circuit City announced that one-time viewing (OTV) of a DIVX disc would cost $4 to $5.

However, users could permanently unlock the discs for an additional fee, so that the total price of an unlocked disc (that is, rental fee plus unlocking fee) would roughly equal the price of a DVD disc. In this way, consumers seemingly had nothing to lose from DIVX.

The DIVX announcement shocked DVD enthusiasts, raising concerns about standards and the specter of monopoly. Unlike open DVD, any hardware or software maker wishing to adhere to the DIVX standard likely would have to pay a licensing fee to Circuit City. Thus Circuit City would have some measure of control over the video industry and stood to profit handsomely if DIVX became the dominant standard.

Early adopters did not know it, but at the time of the DIVX announcement, Circuit City was far away from actually bringing the product to the market. It had neither hardware nor software to demonstrate and was struggling to recruit other retailers to sell DIVX.

As the 1997 Christmas season came and went without any sign of DIVX products, suspicions mounted about the difficulties facing the DIVX launch. On January 17, 1998, Circuit City CEO Richard Sharp made an announcement that seemed to settle the DVD market. He announced that test marketing of DIVX would not begin until the summer. He also indicated that all DIVX players would be initially manufactured by Zenith, which was not a significant force in the audio/video hardware market and was on the verge of bankruptcy. Lastly, he indicated that DIVX would be marketed as an advanced feature of DVD rather than as an alternative standard.

When Circuit City finally launched DIVX in the fall of 1998, it faced an uphill battle. Studio support for DIVX had weakened. At the same time, Circuit City had convinced only one major competitor — The Good Guys — to carry the product. Although Circuit City reported that it sold as many as 80,000 DIVX players in the crucial Christmas 1998 shopping season, this represented less than 25 percent of the sales of open DVD players during the same period. At best, DIVX was destined to be a niche format.

By the spring of 1999, things were looking even bleaker for DIVX. As of May 1999, nearly 2 million DVD players had been shipped to retailers. The DIVX share through that time was at most 165,000. At the same time, there were 3,317 software titles available on the DVD format and only 471 titles available on DIVX. (The 471 titles included many titles available in both formats.) On June 16, 1999, Circuit City pulled the plug on DIVX.

Evaluating Circuit City's Decision

As the 1997 Christmas selling season approached, Circuit City had to nail down its DVD strategy. If it wanted to compete for control over the entire market, it would have to announce the introduction of DIVX as soon as possible. At a minimum, this would slow DVD sales. Otherwise, holiday DVD sales might push the installed base of open DVD beyond the "point of no return," and, at best, Circuit City would compete in the retail market.

We can use economic principles to examine Circuit City's strategy. These principles pertain to markets in which there are "network effects." Network effects are present when consumers place a higher value on a product when the number of other users of that product or a compatible product increases. In "actual" networks, users are physically linked. Examples of actual networks include telephone and e-mail networks. In "virtual" networks, users are not physically linked and the network effect arises from positive feedback from complementary goods. Examples of virtual networks include computer operating systems, VCRs, CD-players, and DVD players.

When there are strong network effects and little functional difference between two incompatible standards, one of the standards typically takes over the entire market while the other is orphaned. (This clearly was the case in the Betamax vs. VHS standards battle.) Incompatible standards can coexist, but only if the standards are highly differentiated and network effects are not strong.

In early 1997 Circuit City chose to compete *for the market* rather than *in the market*. There was one clear factor in favor of this choice. Given the size of the home video market, Circuit City needed only a modest probability of success to justify going it alone. This reflects a general economic principle that goes as follows: *A monopoly in the bush is often worth more than an oligopoly in hand*. In the simplest version of this principle, economic theories show that a monopolist earns more than twice as much as do individual duopolists, all else equal. This implies that the expected profits to a firm that takes a "50 percent chance of monopoly power/50 percent chance of zero profits" gamble exceed the profits to a firm that settles for sharing the market as a duopolist.

In the case of digital video technology, the numbers must have seemed even more attractive to Circuit City. If DIVX became the dominant standard, Circuit City could extract a licensing fee from every unit of hardware and software. Circuit City could extract profits from all phases of the industry, much as Nintendo had enjoyed enormous profits when it maintained a stranglehold over

video gaming technology in the 1980s and extracted profits that might have otherwise gone to upstream game developers and downstream retailers. In contrast, if it accepted the DVD standard, Circuit City might expect to capture perhaps 20 percent of the profits from the U.S. retail hardware business, a somewhat lesser share of profits from selling software, and none of the profits from the hardware manufacturing business. As these businesses were fairly competitive, the profits were unlikely to be very large to begin with.

Despite its late start, Circuit City had reason to be optimistic that DIVX could achieve dominance. While early adopters had embraced the new DVD technology, there were still fewer than 150,000 DVD units in U.S. households. It seemed reasonable to expect that the next batch of adopters might prefer DIVX. After all, DIVX could do anything that DVD could do as well as provide the OTV option. If the OTV option proved to be popular, DIVX could quickly make up lost ground to DVD and eventually win the battle for installed base.

Unfortunately for Circuit City, other economic principles weighed against its decision. Circuit City chose to make DIVX compatible with DVD (in the sense that DIVX players would play all DVD discs) in order to convince potential adopters that there would be sufficient software available for the DIVX format. This is sometimes referred to as one-way compatibility.

Compatibility is likely a good idea when there is already a significant amount of complementary software available for an established standard. But one-way compatibility between competing standards may backfire when both standards are still in their infancy and there is relatively little software available for either standard. Windows succeeded in part because it was backwards compatible with applications software written for DOS. This is because vendors of complementary products — in this case the movie studios — will likely choose to release their software in a form that is compatible with the incumbent technology since it reaches BOTH audiences. This will mean that very little software will be written specifically for the entrant's technology. In such a case, few consumers will have heightened demand for the entrant's product.

This is indeed what happened. The studios were unwilling to release DIVX-only discs, as the incremental cost of releasing the film in DVD format was nil. Circuit City apparently ended up paying as much as $100 million to get a few studios to release a handful of films exclusively on DIVX. (See http://www.fightdivx.com/blockbuster.htm.) The DVD consortium included several film studios, so Sony, Toshiba, and the other hardware makers were able to avoid this kind of expense to assure a steady flow of DVD software.

Perhaps Circuit City's biggest mistake was failing to recognize that developing an installed base requires appealing to early adopters. Early adopters shunned DIVX. Many were videophiles who worried about DIVX quality. They feared that Zenith technology would not match that of other hardware leaders. They also doubted that studios producing DIVX videos primarily for OTV would incur the expenses needed to produce the sharpest images or make "special edition" productions. Circuit City did little to dispel these doubts, announcing that DIVX videos would be released in standard 4:3 format (as opposed to widescreen) with no special editions.

Since early adopters tended to be frequent Internet users, a DVD culture developed on the Internet. Hence it was no surprise when several online hardware and software vendors participated heavily in DVD-related sites. By the middle of 1997 the most popular DVD chat sites were receiving more than 2,000 posts weekly, many from potential early adopters who did not own a DVD player. The concerns about DIVX circulated quickly via the Internet and likely hampered Circuit City's efforts to get the format off the ground.

Circuit City might have overcome the resistance of early adopters had it not ignored another economic principle: Do not forget the value net. The value net emphasizes the importance of relationships with trading partners. As Brandenburger and Nalebuff (1996) point out in their book *Co-opetition*, no firm can succeed in winning the market without willing trading partners.

The value net consists of suppliers, competitors, and producers of complementary products and services. The DVD value net included manufacturers, studios, and retailers, and their fortunes were clearly intertwined. Circuit City found that willing partners for a potential DIVX value net were few and far between.

Most major hardware makers were part of the DVD consortium and had no desire to hand over control to a retailer owning full technology licensing rights. Circuit City could be certain that Sony, Toshiba, Philips, and Matsushista would stay the course with DVD. That left Zenith and, eventually, Thompson (which manufactures the RCA brand) as the only major manufacturers willing to supply DIVX hardware.

On the software (studio) side, Circuit City could count out Columbia (owned by Sony). Warner President Warren Liebenluft had been a vocal proponent of DVD, so Circuit City could count it out as well. The remaining studios expressed no public preference for either format, leaving Circuit City with no allies.

Circuit City also needed the support of retailers. It could rule out its major competitor, Best Buy, which had enthusiastically embraced DVD. Even The Good Guys backed off from supporting DIVX, often relegating "display units" to a back room. Circuit City was not able to build an alliance prior to rollout. Hence, for all intents and purposes, Circuit City had to go it alone.

Another issue facing Circuit City was whether its effort to win the market outright might backfire, so that the market would fail to materialize altogether. This reflects the principle that firms should make sure at least one format survives. Format wars may cause consumers to sit on the fence rather than make a commitment to a format that might lose. This occurred in the DVD market, when Circuit City's preannouncement caused sales of all forms of DVD/DIVX hardware to fall by as much as 20 percent (Dranove & Gandal, 2003). This could have been a crippling blow to the fledgling technology. Many early adopters were awaiting the possibility of digital video streaming over the Internet. A two- or three-year delay in the acceptance of DVD might have discouraged the fence sitters from ever adopting the technology.

Given its inability to build up a value net, Circuit City's better strategy might have been to abandon DIVX prior to the rollout and to join the DVD value net. Not only would this have guaranteed the survival of one of the technologies, Circuit City would likely have faced less hostility from early adopters of DVD (see below.)

The confusion caused by the preannouncement angered early adopters, who denounced Circuit City at various Internet sites. Some apparently even visited Circuit City stores to dissuade customers from buying DIVX. This active effort by early adopters to promote a unified standard seems unprecedented.

We know of no other example where consumers communicated in such massive numbers and coordinated activities in behalf of an emerging standard. Hence a final lesson is that communications and coordination among consumers via the Internet will likely play a big role in future standards battles.

Chat groups helped consumers communicate information and coordinate actions. Since many of the early adopters were also Internet users, the large number of active DVD and DIVX Web sites conveyed very useful information to potential adopters in real time. The information spread across the Internet turned out to be remarkably accurate. Internet chat sites correctly anticipated the nature of Circuit City's new technology, the difficulties that Circuit City would have in enlisting partners, and the dip in sales that would result from market confusion. The ability of the Internet to convey information quickly and

inexpensively may reduce market failures associated with competition between incompatible technologies.

Managers need to take this into account when formulating their strategy. Had Circuit City taken into account the strong preferences of early adopters for widescreen format and the ability of early adopters to communicate and coordinate via the Internet, it might have adopted a different strategy.

Post Mortem

Circuit City needed to garner the support of early adopters, hardware and software makers, and at least some retailers. But early adopters shunned DIVX, as did hardware and software makers and retailers.

It was probably not a wise decision to choose compatibility with DVD. While this assured purchasers of DIVX that they would not be orphaned, it likely encouraged movie studios to release primarily in DVD format, since they could reach all consumers in this fashion. But if Circuit City had issued a fully incompatible standard, it may have been no better off. Users probably would not have had sufficiently strong preferences for the OTV feature to ensure that DIVX could survive, even as a niche player.

Circuit City may have also erred when it priced its DIVX players at a 10 to 15 percent premium above comparable DVD players. This may have been enough to convince some purchasers to stick with open DVD. Circuit City could have subsidized the purchase of the DIVX player in order to create a large installed base. But this may have triggered a fierce price war, as evidenced by the price cuts that DVD manufacturers implemented when DIVX hit the market.

For all the reasons discussed, Circuit City's odds of winning the market were low. But what if it had elected to compete within the market? Circuit City was the nation's number one electronics retailer overall. If the DVD market took off, could it expect to reap its fair share of profits? To answer this question, it is important to examine events that had unfolded prior to the DIVX announcement date.

By the fall of 1997, Best Buy already had made a major commitment to DVD. Best Buy stores had extensive selections of hardware and software and aggressively promoted DVD both through advertising and in-store promotional

displays. Best Buy was rapidly establishing an identity as the place to go for DVD.

The growth of e-commerce was also threatening Circuit City's dominance. By fall 1997 there were already several online DVD retailers, including mass merchandisers Amazon and Buy.com. Even if Circuit City had competed in the market, it seems unlikely that it could expect to be the only dominant retailer.

Nevertheless, it probably would have been a better choice than going alone. Indeed, if Circuit City had elected to embrace DVD in its earliest stages, rather than introduce DIVX, it could easily have matched Best Buy's retailing strategy. This would have secured its position as the U.S.'s number one bricks and mortar retailer while accelerating the success of DVD.

Summary of Principles

We now summarize the six principles we believe that a firm must consider when deciding how to compete in a market with evolving standards:

- **Principle 1:** A monopoly in the bush is often worth more than an oligopoly in hand; that is, under certain conditions it will be worthwhile to compete "for the market" rather than "compete within the market".
- **Principle 2:** One-way compatibility between competing standards may backfire when both standards are still in their infancy and there is relatively little software available for either standard. The reason is that vendors of complementary products will likely choose to release their software in a form that is compatible with the technology that reaches *both* audiences.
- **Principle 3:** Firms competing in markets with network effects must ensure that their technology appeals to early adopters. Otherwise, a bandwagon of support can build an insurmountable lead for another technology.
- **Principle 4:** Firms should ensure that they have a formidable value net, which consists of suppliers, competitors, and producers of complementary products and services. This is especially important in industries with network effects.
- **Principle 5:** Make sure at least one format survives. If complementary product providers support different incompatible standards, demand may

be very low for each of the incompatible standards and both might fail.

- **Principle 6:** Communications among consumers via the Internet will likely play a big role in future standards battles. While the DVD vs. DIVX battle was likely the first key standards war where coordination among consumers via the Internet had a major impact, the Internet will surely play a key role in future standards' competition.

Principles in Action: Another Standards War is Brewing

In closing, we take a look at the principles in action in the context of a new yet related standards battle. The early adopters of DVD are carefully watching the emerging competition between two incompatible formats, Super Audio CD (SACD) and DVD-Audio. These technologies offer surround sound coupled with music quality that audiophiles claim is superior to standard compact discs. Sony owns the SACD format and includes SACD decoding on many of its high-end DVD players. The open DVD-Audio format is often included on high-end DVD players made by other manufacturers as well as Sony. As of this writing, there are nearly 1,000 titles available in SACD and a few hundred in DVD-Audio, with little overlap. While this sounds like a large selection, remember that the number of music recordings vastly exceeds the number of movies. (For example, Amazon.com currently lists more than 1,000 recordings containing at least one work by composer Gustav Mahler.) At any time, perhaps 5 percent of the top 100 selling music titles are available in one of the high-resolution formats. (Of the 1,000-plus Mahler titles, only six are available in SACD.)

It is not clear if either format can thrive, even if the format war is resolved. One deterrent is the cost of upgrading. Hardware makers currently charge $50 to $500 to upgrade a traditional DVD player to the high-resolution audio formats. Proper playback of either format also requires additional cables and, potentially, additional hardware to handle the surround sound. Most consumers already believe that compact discs sound "perfect" and lack the kind of expensive audio equipment that brings out fully the benefits of the new formats. Moreover they have been assaulted by new formats for other technologies (especially DVD) and may be unprepared for another spending spree. Thus the demand for these audio formats may be limited (principle 5).

At the same time, electronics retailers are not very enthusiastic about the new formats (principle 4). Best Buy and Circuit City are still educating consumers about DVD and hope that the new video technology spurs demand for big screen televisions and surround-sound home theaters. Most early adopters of high-resolution audio already have the necessary cables and hardware, so there is little additional profit from these items. At best, electronics retailers could hope to sell additional software, but the current titles are often obscure (mainly classical and jazz) and do not fit in with current music title selections at most retailers. Indeed it is difficult to find SACD and DVD-Audio at most electronics retailers, and the selection is very limited. (Best Buy carries some recordings in the DVD section, while others are in the music department.) This contrasts sharply with Best Buy's early promotions of DVD, which featured dedicated displays and shelf space.

The format war is only making matters worse. Most audiophiles remain on the fence. Posters to audiophile Web sites bemoan the lack of major studio support, as most of the software comes from independent studios **(**principle 3**).** Many high-end retailers advise their customers to hold off making any purchase until the format war is decided.

Which format has the best chance of surviving? Many classical and jazz labels are releasing in SACD format. Although these represent a small percentage of total CD sales, they are especially popular among audiophiles who frequent Web sites devoted to the new technologies. For example, the vast majority of posters to the Audio Asylum chat group on high-resolution audio prefer the SACD format (principle 3). On the other hand, DVD-Audio is currently included in more hardware. Even so Sony is the only major hardware maker that stands to gain much from sales of either format, due to sales of its Sony Music label recordings. Other hardware makers are content to sell DVD-only players, realizing scant additional profits from the DVD-Audio feature. This suggests that Sony has greater incentive to make the investments necessary to win over more recording studios and retailers.

Thus far, Sony has scored one coup by convincing ABKCO/London Records to release the Rolling Stones catalog in SACD. The buzz on the Internet is that many potential early adopters are waiting to see what will happen to the Beatles catalog (principle 6). If Sony plays its cards right, through aggressive licensing arrangements with software and hardware makers, joint ventures with Best Buy and other retailers, and a few more high-profile releases like the Rolling Stones, it stands a good chance of winning the market for high-end surround sound audio (principle 4).

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Chapter II

Information Transparency Hypothesis: Economic Implications of Information Transparency in Electronic Markets

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Abstract

This chapter explores the private and social desirability of information transparency of a business-to-business (B2B) electronic market that provides an online platform for information transmission. The abundance of transaction data available on the Internet tends to make information more transparent in B2B electronic markets. In such a transparent environment, it becomes easier for firms to obtain information that may allow them to infer their rivals' costs than in a traditional, opaque market. How then does this benefit firms participating in the B2B exchanges? To what extent does information transparency affect consumers and the social welfare in a broader sense? Focusing on the informational effects,

this study explores firms' incentives to join a B2B exchange by developing a game-theoretic model under asymmetric information. We then examine its effect on expected profits, consumer surplus, and social welfare. Our results challenge the "information transparency hypothesis" (that is, open sharing of information in electronic markets is beneficial to all participating firms). In contrast to the popular belief, we show that information transparency could be a double-edged sword. Although its overall effect on social welfare is positive, its private desirability is deeply divided between producers and consumers, and even among producers themselves.

Motivation

Despite the controversies surrounding B2B online exchanges, the Internet-based electronic marketplaces are considered to have the potential to reduce transaction costs, add product and pricing transparency, generate market liquidity, and facilitate bidding by a broad spectrum of potential suppliers in a standardized platform (Mullaney, 2003). Here we define a B2B marketplace as an online platform that creates a trading community linked by the Internet and provides the mechanism for B2B interactions using industry-wide data standard and computer systems. Online B2B exchanges allegedly streamline information flow in supply chains (Lee & Whang, 2000) and make the information more widely available (Agrawal & Pak, 2002). The re-balance of information asymmetry is an important motivation for establishing B2B exchanges (Hoffman, Keedy & Roberts, 2002). Yet, given these multiple benefits, why is it that B2B exchanges have not been widely adopted? Why are suppliers still reluctant to join a high-profile exchange such as Covisint (Koch, 2002)? B2B exchanges indeed seem to improve information transparency, but is information transparency a benefit or a threat? It has been a popular belief that open sharing of information in electronic markets is beneficial to all participating firms, which we term as the "information transparency hypothesis." One of the objectives of our chapter is to scrutinize these kinds of claims by economic analysis.

Information technology (IT) has in general improved the flow of information (Zhu, 1999). B2B electronic exchanges in particular provide an online platform through which information is gathered, compiled, displayed, and transmitted

among participating companies (Zhu, 2002). In this sense, online B2B exchanges play a role of transmitting or aggregating information within a particular industry (Hansen, Mathews, Mosconi & Sankaran, 2001). Examples include Covisint in the automobile industry, and Exostar in the aerospace industry.[1]

The proliferation of these Internet-based marketplaces creates a vast sea of information about products, prices, transactions, and costs. Today a significant flow of information is being exchanged between buyers and sellers, between suppliers and manufacturers, and among competitors. This makes information more transparent in electronic markets than in traditional physical markets. *Information transparency* is defined as the degree of visibility and accessibility of information. The subject of information in the context of electronic markets has gained the interest of both academics and practitioners. Bakos (1998) describes the three main functions of markets: matching buyers and sellers, facilitating the exchange of information, and providing an institutional infrastructure. In this chapter we focus on the second role, as the digitization of information combined with high-speed networks has heightened the role of information in electronic markets. Data are real time, more transparent, and more synchronized; information flows more instantaneously in electronic markets (Grover, Ramanlal & Segars, 1999). In this regard, information transparency becomes one of the key features that distinguish digital exchanges from traditional markets (Zhu, 2002).

The Internet increases information transparency in several ways. The Internet in general not only contains abundant information but also reduces the search cost for that information (Bakos, 1997). More specifically, using reverse-auction bidding, XML mapping, data mining, and intelligent agent technologies, online exchanges allow participants to obtain information that might be useful to infer rivals' costs more easily than they can with traditional markets in which inferring costs has been cumbersome (Sinha, 2000). It is often the case that data regarding prices, quantities, and bidding specifications are recorded in a database and made available to participants of the exchanges. For instance, on Covisint, suppliers can see who is selling brakes and clutches, at what prices, and in what quantities. As posted on its Web site (www.covisint.com), "Covisint allows you to quickly share critical information … and to browse, as well as receive and transmit electronic information." There are many such real-world examples illustrating that cost information is more transparent on electronic exchanges than in traditional markets.[2]

In this chapter we leave out the details of the process of price discovery and information transmission. Instead we focus on the equilibrium effects of such

information transmission. Transparent information is typically regarded as a good thing due to possible efficiencies arising from more widespread dissemination of accurate information. Yet, "to have a full collaborative environment is a hard sell for me … what I am going to lose in terms of visibility and exposing my information to potential competitors is greater than what I would gain on the collaboration side" (Meehan, 2001). Indeed, are B2B exchanges likely to promote efficiency and yield social welfare benefits, or are they more likely to be used to squeeze margins and impose price pressure on small suppliers? This possibility is evidenced by the concern being expressed by suppliers over the power that carmakers may wield through the Covisint exchange (FTC, 2000). That there are risks, as well as potential gains, associated with possible cost information exchange via online marketplaces is reflected in the investigations conducted by regulation authorities on several B2B exchanges (CRN Business Weekly, 2000; Disabatino, 2002; FTC, 2000).

These issues give rise to a set of critical research questions regarding the informational role of online B2B marketplaces. We are concerned with the private incentives and social welfare of information exchange. Research questions of particular interest include:

- What incentives will firms have to join the B2B exchange?
- Will the introduction of the B2B exchange benefit the industry?
- How does information transparency benefit (or hurt) consumers and society in a broader sense?

Intuitively, information aggregation tends to have two types of effects: the *direct effect* on the firm and the *cross effect* on its rivals (Zhu, 2004). First, receiving more accurate information permits the firms to choose the strategies that are more finely tuned to the actual state of the market and hence improve the profits, so the increased transparency of information for a firm has a positive effect. On the other hand, transparent information may affect the degree of correlation among the strategies of all other firms. The increased strategy correlation and the increased precision of the rivals have a rather subtle, complicated effect on the behavior of the firms. The equilibrium behavior is not clear without a rigorous model.

Seeking to better understand these issues, we built a simple game-theoretic model, with some abstractions and assumptions, so that we can begin to study the informational effects of B2B marketplaces. We utilized the concept of

fulfilled rational expectations equilibrium with incomplete information.[3] One implication of this equilibrium concept is that the market participants incorporate the information that is contained in the equilibrium strategies in their decision-making process. This reflects the aggregation and transparency of information in a market mechanism with very little friction, such as an Internet-based B2B exchange (Zhu, 2004).

Our model shows that firms' incentives to join a B2B exchange are sensitive to their relative cost positions. Firms with heterogeneous costs have different incentives for information exchange. We also find that information transparency benefits some firms but hurts others. For substitute products, profits and market share will be *redistributed* from high-cost firms to low-cost firms. Under the assumptions of our model, producer surplus will rise due to more efficient allocation of production quantities, yet consumer surplus can be higher or lower.

Relationship to Other Studies

Due to the recent emergence of B2B exchange as a recognizable economic phenomenon, prior research aimed directly at the questions posed here has been limited (Kauffman & Walden, 2001). Some more general theory, however, has been developed in the literature of industrial organization and information economics. The literature has shown steady interest in the issue of information sharing among oligopolists, which had an early start with Novshek and Sonnenschein (1982) and Clarke (1983) and was continued by Vives (1984), Gal-Or (1986), Vives (1990), and Malueg and Tsutsui (1998), among others. All of these papers considered information sharing about market *demand* in a duopoly context. In those typical models with demand uncertainty, firms are uncertain about the intercept of a linear demand curve (where all firms face the same common disturbance in their demand functions). Papers about *cost* uncertainty are relatively rare.[4] Shapiro (1986) and Li (1985) considered information sharing about costs among Cournot oligopolists, both motivated by an antitrust perspective and focused on whether information sharing would make the market more or less competitive. In contrast our perspective is about the incentive and welfare implications of information transparency on B2B exchanges. Their models assumed homogeneous products, linear demand, and constant marginal cost. They studied two extreme information-sharing scenarios: either industry-wide complete information pooling or no information

sharing at all. We build on these studies, particularly the game-theoretic modeling of information sharing among oligopolists, and address additional concerns arising in the B2B exchange context. After we present our model, we will re-visit this issue and compare our results with the literature.

The remainder of the chapter proceeds as follows. The next section presents the basic setup of the model. The incentives section analyzes firms' incentives to join a B2B exchange. The welfare implications section extends the model to analyze the broader welfare effects on the industry, the consumers, and the society. Implications are discussed in the final section. To stay within the page limit, we emphasize the economic rationale rather than mathematical derivations.[5]

Model

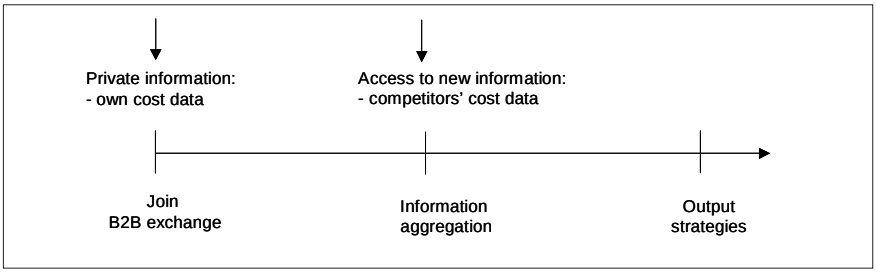
We consider a market in which there are a finite number of n suppliers ($n \geq 2$), and each firm's technology is subject to uncertainty. They can trade through either traditional bilateral contracting or a neutral B2B online exchange. The B2B exchange makes certain transaction data visible on its Web site. The sequence of events occurs as follows: (1) each firm decides whether or not to join the B2B exchange with an understanding that the B2B exchange will make signals regarding its cost data visible to other exchange members; (2) with its own cost data endowed initially, each firm may access additional information about other firms' costs on the B2B exchange, depending on its decision from stage (1); and (3) each firm chooses its output level, conditional on its information set from stage (2). This three-stage timing structure is illustrated in Figure 1. Notice that firms make decisions simultaneously, and they do not announce their participation decisions until the game is over.

We use a simple linear demand function to represent the buying side:

$$p_i = d - q_i - \theta \cdot \sum_{j \neq i} q_j , \qquad i = 1, 2, \ldots, n \tag{1}$$

Here p_i is the price, q_i is the quantity, d is the demand intercept, and θ denotes the degree of product differentiation where products are substitutes, comple-

Figure 1. Sequence of events



ments, or independent, depending on whether $\theta > 0$, $\theta < 0$, or $\theta = 0$. We assume there is a continuum of buyers in the market so that their individual decisions do not influence the market outcome. This allows us to focus on the strategic interactions of the suppliers.

The technology is stochastic and exhibits constant returns to scale. In other words, each firm employs a technology with a marginal cost, denoted by c_i for firm i:

$$C_i(q_i) = c_i\, q_i + F, \qquad i = 1, 2, ..., n. \tag{2}$$

That is, each firm's marginal cost c_i is a random variable. F is the constant fixed cost. The cost vector $\boldsymbol{c} = (c_1, c_2, ..., c_n)'$ follows an n-dimensional multivariate normal distribution. Its joint distribution is defined by $\boldsymbol{c} \sim N(\mu, \Sigma)$ with mean $\mu \in R^n$ and covariance matrix $\Sigma \in R^{n \times n}$, where $\mu_1 = ... = \mu_n = \mu > 0$ and

$$\Sigma = \begin{pmatrix} \sigma^2 & \rho\sigma^2 & \cdots & \rho\sigma^2 \\ \rho\sigma^2 & \sigma^2 & \cdots & \rho\sigma^2 \\ \vdots & \vdots & \ddots & \vdots \\ \rho\sigma^2 & \rho\sigma^2 & \cdots & \sigma^2 \end{pmatrix}_{n \times n} \tag{2'}$$

where ρ is the correlation coefficient between any pair (c_i, c_j) $j \neq i$ with $\rho \in (0,1)$.

While the joint normal distribution $N(\mu,\sum)$ is common knowledge, an individual firm's cost is private information. Without the B2B exchange, firm *j* observes only its own cost, c_j, but not those of the other firms. In contrast, member firms in the B2B exchange may have access to additional information — they observe signals that are correlated to the costs of the firms trading on the B2B exchange, $(c_1,...,c_k)$, where $0 < k \leq n$.

We restrict our attention to a class of distributions such that the conditional expectations obey a linear property, namely, Linear Conditional Expectation (LCE) property (Zhu, 2004):

$$E[c_j \mid c_i] = \mu + \rho(c_i - \mu), \qquad i, j = 1,...,n;\ i \neq j. \tag{3}$$

Further, given the cost information of any subset $K \subseteq N$, one can form the conditional expectations for $c_j, j \in N \setminus K$, as:

$$E[c_j \mid c_1,...,c_k] = \mu + \frac{\rho}{1+\rho(k-1)} \sum_{i \in K} (c_i - \mu), \quad \text{for} \quad j \in N \setminus K. \tag{4}$$

Notice that for $k = 1$, conditional expectation (4) reduces to (3). It has been shown that the LCE property in (3) and (4) is valid for multivariate normal distribution (Basar & Ho, 1974; Shapiro, 1986). The LCE property means that, for a multivariate normal distribution, its regression equations (conditional means) are linear functions of the conditioning variables. The parameters of the regression functions are determined by the covariance structure (that is, ρ). Given their information sets upon joining the B2B exchange, firms will update their conditional belief about other firms' cost, and the conditional expectations obey a linear function. That is, $c_i (i \in K)$ can be used to update posterior expectations on c_j via the mechanism specified by (3) and (4).

The notion of fulfilled expectations equilibrium requires not only that firms maximize expected profit given their information set, but also that their strategies not be controverted. This means that, when each firm uses its conditional distribution in (4) and maximizes expected profit as a Bayesian-Nash equilibrium, the realized distribution is precisely the one given by the conditional belief that is held by the firm (Zhu & Weyant, 2003).

We focus on the informational consequences of joining the B2B exchange. After firm *i* joins the exchange, its trading activities will be recorded in the exchange database, which may reveal its cost, c_i, to other member firms belonging to the exchange. In return it can observe the costs of other firms that are also trading on the exchange. The set $N = (1,2, ..., n)$ of all n firms is partitioned into two subsets, the set K of $k = |K|$ firms that join the B2B exchange and its complement set $N \setminus K$ of $(n\text{-}k)$ firms that trade outside of the B2B exchange (e.g., through traditional bilateral negotiation and contracting). This is shown in Figure 2. Hence, the essential difference between the two sets of firms is their distinct information structures.

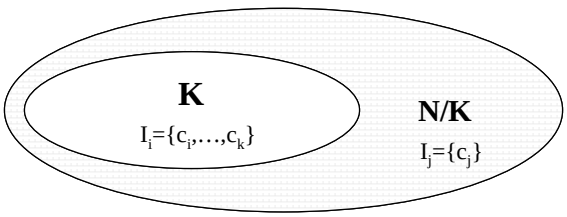
By this construction, the set of firms in K obtains information from their participation in the B2B exchange to which no firm in $N \setminus K$ belongs. Their information set is:

$$I_i = \{c_1, ..., c_i ..., c_k\}, \qquad \text{for} \quad i \in K, \tag{5}$$

where I_i denotes the information set available to firm *i*. Joining the B2B exchange revises firm *i*'s information set from $\{c_i\}$ to $\{c_1, ..., c_i, ..., c_k\}$. For the $(n\text{-}k)$ firms in the set $N \setminus K$ that trade outside of the B2B exchange, each firm's information set is confined to its own cost. That is:

$$I_j = \{c_j\}, \qquad \text{for} \quad j \in N \setminus K. \tag{6}$$

Figure 2. B2B exchange members and non-members as two subsets



To sum up this section, we have made the following assumptions:

A1: Demand and cost functions are represented by (1) and (2);

A2: Firms use (3) and (4) to update their conditional belief about rivals' costs;

A3: The B2B exchange facilitates information transparency in the sense that observed transaction data are perfectly correlated with costs (i.e., no noise in the signals).

A4: The transmission of information can only be done through the B2B exchange.[6]

Incentives to Join the B2B Exchange

Given the above assumptions and the model setup, we proceed to derive the equilibrium quantities and profits under two information structures. Firms maximize their expected profits by choosing output levels non-cooperatively for the given information structure, assuming that all other firms behave the same; namely, they play a Cournot game. Following the standard game-theoretic approach (Fudenberg & Tirole, 1991), the equilibrium notion we use is that of a Bayesian-Nash equilibrium, which requires that each firm's strategy be a best response to its conjectures about the behavior of the rivals, consistent with their beliefs about other firms' costs (Tirole, 1988). By backward induction, we first examine the last stage (optimal quantities) and then work backward to analyze the first stage (whether to join the B2B exchange).

Optimal Quantities

We derive the optimal strategies corresponding to two different information sets in (5) and (6) associated with B2B exchange members and non-members, respectively. Given the demand function in (1) and cost function in (2), profit can be computed as:

$$\pi_i = (p_i - c_i)q_i = \{d - q_i - \theta \Sigma q_j - c_i\}\, q_i .$$

Taking expectations, conditional on its information set $I_i = \{c_1, ..., c_k\}$, a member firm *i* maximizes its expected profit:

$$\max_{q_i} E[\pi_i \mid I_i] = \{d - q_i - \theta \sum_{\substack{m=1 \\ m \neq i}}^{k} E[q_m \mid I_i] - \theta \sum_{j=k+1}^{n} E[q_j(c_j) \mid I_i] - c_i\} q_i ,$$

$$i \in K \tag{7}$$

Solving the first order conditions jointly yields the following optimal quantity (Zhu, 2004):

$$q_i^* = \bar{q} + \psi \sum_{m=1}^{k} (c_m - \mu) - \phi(c_i - \mu), \qquad i \in K, \tag{8}$$

where

$$\bar{q} = \frac{d - \mu}{2 + (n-1)\theta}$$

$$\psi = \frac{1}{k\theta + 2 - \theta} \left[\frac{\theta}{2 - \theta} + \frac{\beta\rho\theta(n-k)}{1 + \rho(k-1)} \right] \tag{9}$$

$$\phi = \frac{1}{2 - \theta}, \qquad (\theta \neq 2) \tag{10}$$

where $\bar{q}$ is the equilibrium quantity in the absence of cost uncertainty (that is, if output were all produced at a constant cost, μ). Sensitivity coefficient ϕ represents a "direct" adjustment to the firm's own cost, and ψ represents a "counter" adjustment to rivals' costs. Sensitivity ψ also depends on non-members' behavior, β, which will be determined soon. This means that the "direct" and "counter" adjustments by the member firms involve the behavior of the non-members. Examining the equilibrium quantities in (8) leads to the following observation:

Lemma: The equilibrium strategy for each firm in the B2B exchange is affine in its private cost, c_j, as well as in the revealed cost data from the exchange, $(c_1, ..., c_k)$, with direct adjustment ϕ and counter adjustment ψ to the cost information.

Now consider the profit-optimization problem of a non-member firm, $j \in N \setminus K$. Not having access to the information aggregated on the B2B exchange, each firm's information set is confined to its own private cost data, c_j, at the time when it makes its output decisions. Firm j maximizes its expected profit, conditional on its information set, $I_j = \{c_j\}$:

$$\max_{q_j} E[\pi_j \mid I_j] = \{d - q_j - \theta \sum_{i=1}^{k} E[q_i \mid c_j] - \theta \sum_{\substack{m=k+1 \\ m \neq j}}^{n} E[q_m \mid c_j] - c_j\} q_j ,$$

$$j \in N \setminus K \tag{11}$$

Solving the first order conditions yields (Zhu 2004):

$$q_j^* = \bar{q} - \beta(c_j - \mu) , \tag{12}$$

where

$$\beta = \frac{[1+\rho(k-1)][2+(k-1-\rho k)\theta]}{[2+\theta\rho(n-k-1)][2+(k-1)\theta][1+\rho(k-1)] - k^2\theta^2\rho^2(n-k)} \tag{13}$$

The equilibrium strategy for a non-member firm is a linear function of the base quantity, $\bar{q}$, and its private cost, c_j, adjusted by sensitivity coefficient β. The coefficients ϕ, ψ, and β represent the behavior of the member and non-member firms.

Equilibrium Profits

In order to analyze the formation of the B2B exchange, it is necessary to derive and compare the equilibrium profits for members $E[\pi_i^*]$ and non-members $E[\pi_j^*]$, respectively, for any given exchange membership size, k, where $k = |K|$, $K \subseteq N$. Substituting the optimal strategies, q_i^* in (8) and q_j^* in (12), into the profit functions in (7) and (11), and using the conditional expectations (3) and (4), we derive the following result:

Proposition 1 (equilibrium profits):
In equilibrium, a member can expect to make a profit as:

$$E(\pi_i^*) = [E(q_i^*)]^2 + \psi^2 (k-1)[1+(k-2)\rho]\sigma^2, \qquad i \in K. \tag{14}$$

A non-member can expect to make a profit as:

$$E(\pi_j^*) = [E(q_j^*)]^2, \qquad j \in N \setminus K. \tag{15}$$

Here, $\psi^2 (k-1)[1+(k-2)\rho]\sigma^2 > 0$, the expected profits of the exchange members increase in the variance of the cost, σ^2. This reflects the convexity of profits as a function of costs. It can be shown $\partial\Delta\pi/\partial\sigma^2 = \psi^2 (k-1)[1+(k-2)\rho] > 0$, then:

Corollary 1 (property of convexity): Firms would have stronger incentives to join the B2B exchange when they face higher uncertainty, that is, $\partial\Delta\pi/\partial\sigma^2 > 0$.

Term $\psi^2 (k-1)[1+(k-2)\rho]\sigma^2$ represents the benefits of information aggregation on the B2B exchange. It would be more valuable when the uncertainty, σ^2, is higher. This result is consistent with our positioning conceptualized earlier that B2B exchange serves as an information-transmission platform.

Who Will Join the B2B Exchange?

Having derived the optimal outputs and equilibrium profits, we are now prepared to determine whether the firms in the exchange can expect to make higher profits than the non-members. Each firm considers information exchange beneficial in the classical Pareto-dominance sense when $E[\pi_i^*] > E[\pi_j^*]$, for any given exchange size, k, $i \in K$ and $j \in N \setminus K$.

To compare the expected profit of joining the exchange versus staying offline, we need to quantify the expected profit difference, $\Delta\pi = E[\pi_i^*] - E[\pi_j^*]$, from (14) and (15), as:

$$\Delta\pi = [E(q_i^*)]^2 - [E(q_j^*)]^2 + \psi^2(k-1)[1+(k-2)\rho]\sigma^2 .$$

Defining $\Delta c \equiv c_i - \mu$, and plugging the expectations of (8) and (12), $\Delta\pi$ can be written as a quadratic function of Δc:

$$\Delta\pi = (\psi - \phi + \beta)(\psi - \phi - \beta)(\Delta c)^2 + 2(\psi - \phi + \beta)\bar{q}\,\Delta c + \psi^2(k-1)[1+(k-2)\rho]\sigma^2.$$

By examining its first and second derivatives, we found that $\Delta\pi$ is a convex, U-shaped curve. Solving the equation $\Delta\pi = 0$ yields:

$$\hat{c} = \mu + \frac{\bar{q} - \sqrt{\bar{q}^2 - \dfrac{\psi - \phi - \beta}{\psi - \phi + \beta}\psi^2(k-1)[1+(k-2)\rho]\sigma^2}}{\phi + \beta - \psi}, \qquad (16)$$

where $\hat{c}$ represents the threshold cost below which $\Delta\pi \geq 0$. That is, when $c_i \leq \hat{c}$, $E[\pi_i^*] \geq E[\pi_j^*]$. This implies that firms with low cost, $c_i \leq \hat{c}$, will have an incentive to join the B2B exchange, as they will derive higher profits than if they stay offline. In contrast, firms with high cost, $c_i > \hat{c}$, will lack the incentive to join the B2B exchange. This is summarized next.

Proposition 2 (equilibrium solution – who will join the B2B exchange): Cost heterogeneity induces different incentives to join the B2B exchange. In equilibrium, low-cost firms will find it optimal to join the online exchange while high-cost firms will not. That is:

$$\Delta\pi = \begin{cases} \geq 0, & \text{if } c \leq \hat{c} \\ < 0, & \text{if } c > \hat{c} \end{cases}$$

where threshold cost $\hat{c}$ is defined in (16).

The basic tradeoff that drives the incentives for a firm to trade on the B2B exchange is the increased precision of information, decomposed in the effect on the firm itself and on its rivals, and the correlation induced in the strategies of the firms. By making cost data more transparent and by "advertising" their relatively aggressive reaction curves, the low-cost firms induce the rivals to shrink their outputs. This leads to a more efficient allocation of output (and market share) than what would arise in the absence of information transparency. Without the transparent information facilitated by the B2B exchange, all firms would estimate their rivals' costs based on their limited private information, which tends to make their estimates around the mean of the cost, μ. With the B2B exchange, the fog clears out and the firms can see through each other's costs better than before. In the new information-transparent equilibrium, more efficient firms produce more. Hence the mix of output (and market share) is shifted from high-cost firms to low-cost firms. This would result in very different incentives toward information transparency on the B2B exchange: in equilibrium we will find that low-cost firms will prefer to trade on the transparent online exchange, while high-cost firms will have incentives to trade in an opaque environment where they can hide their "uncompetitive" costs.

With the result in Proposition 2, we can now make the notion of "low-cost" and "high-cost" more precise. Low-cost firms are those firms whose costs are below the critical level, that is, $c_i < \hat{c}$. High-cost firms are those whose costs are above the critical level, that is, $c_i > \hat{c}$. That is, $c_H = \{c_i, \forall c_i > \hat{c}\}$ and $c_L = \{c_i, \forall c_i \leq \hat{c}\}$. This cost heterogeneity permits the possibility of a separating equilibrium as follows.

Corollary 2 (separating equilibrium): In equilibrium, those firms trading through the B2B exchange are expected to be the more efficient (with lower costs or better technology) firms, while those less efficient (higher-cost) firms continue to trade through the traditional markets such as bilateral contracts or negotiation.

Given the separating-equilibrium nature induced by information transparency, the mere existence of the online exchange makes it more difficult for high-cost firms to hide their cost data. The B2B exchange as a new technology helps the market to sort out efficient firms from inefficient ones. Besides information revealed from online transactions data, the action to join or not to join the B2B exchange itself may single out the high-cost firms. For example, if firm *j* chooses to stay away from the B2B exchange, then other firms could infer that firm *j* is likely to be a high-cost firm (although they still do not know firm *j*'s exact cost). Therefore, *even though they choose not to participate in the online marketplace, high-cost firms are made worse off by the mere existence of the B2B exchange in the industry*.

Finally, it can be shown that:

$$\frac{\partial \hat{c}}{\partial \sigma^2} > 0,$$

meaning if $\sigma^2 \uparrow$, then $\hat{c} \uparrow$, so more firms will find it profitable to join the exchange. Consequently, when uncertainty of information rises, firms would have stronger incentives to participate in the B2B exchange, and the exchange's membership size and critical mass will increase. Hence uncertainty works to the advantage of the B2B exchange and its members.

Welfare Implications: Private and Social Desirability of Information Transparency

We have explored the incentives for individual firms to join a B2B exchange that serves as an information exchange mechanism. Yet to what extent does greater

information transparency affect the welfare of producers, consumers, and the society in a broader sense? Especially, how does B2B exchange benefit (or hurt) consumers? To answer these questions, we now proceed from private incentives to social consequences of B2B information exchange and examine the welfare implications for the industry, consumers, and society.

We do so by comparing the opaque and transparent information equilibria on an *ex ante* basis. Specifically, based on firm's equilibrium quantities and expected profits shown in the previous section, we first derive the expressions of producer surplus (*PS*), consumer surplus (*CS*), and social welfare (*SW*). Then we examine whether information transparency is socially beneficial by comparing these welfare terms under two information structures, corresponding to the two scenarios with and without the B2B exchange.

The welfare measures can be expressed in terms of variance and covariance of output quantities and costs. Starting from expected profit, we have:

$$\begin{aligned} E[\pi_i] &= E(p_i q_i) - E(c_i q_i) = Cov(p_i, q_i) + E(p_i)E(q_i) - Cov(c_i, q_i) - E(c_i)E(q_i) \\ &= \bar{\pi}_i + Cov(p_i, q_i) - Cov(c_i, q_i) \end{aligned} \tag{17}$$

where $\bar{\pi}_i = (E(p_i) - \mu)E(q_i)$ represents the baseline profit without cost uncertainty. Using (1), it is straightforward to show:

$$Cov(p_i, q_i) = -Var(q_i) - \theta \sum_{j \neq i} Cov(q_i, q_j).$$

Inserting it into (17) yields:

$$E[\pi_i] = \bar{\pi}_i - \underbrace{[Var(q_i) + Cov(c_i, q_i)]}_{\text{own effect}} - \underbrace{\theta \textstyle\sum_{j \neq i} Cov(q_i, q_j)}_{\text{interraction effect}}, \tag{18}$$

where the first term represents single-firm *own effect* and the second represents multi-firm *interaction effect*. The own effect means the effect on the firm itself, while the interaction effect means the cross effect that involves other firms.

Let $E[PS]$ denote the expected producer surplus. Then from (18), we have:

$$E[PS] = \sum_i E[\pi_i] = \overline{PS} - \sum_i \underbrace{[Var(q_i) + Cov(c_i, q_i)]}_{own\ effect} - \theta \sum_i \underbrace{\sum_{j \neq i} Cov(q_i, q_j)}_{interaction\ effect}, \quad (19)$$

where $\overline{PS} = \sum_i \bar{\pi}_i$. Similarly, expected consumer surplus, $E[CS]$, can be obtained as:

$$E[CS] = \overline{CS} + \tfrac{1}{2} \sum_i \underbrace{[Var(q_i)]}_{own\ effect} + \tfrac{1}{2} \theta \sum_i \underbrace{\sum_{j \neq i} Cov(q_i, q_j)}_{interaction\ effect}. \quad (20)$$

If we sum the expected producer and consumer surpluses, we get the expected social welfare as follows:

$$E[W] = E[PS] + E[CS] = \overline{W} - \sum_i \underbrace{[\tfrac{1}{2} Var(q_i) + Cov(c_i, q_i)]}_{own\ effect} - \tfrac{1}{2} \theta \sum_i \underbrace{\sum_{j \neq i} Cov(q_i, q_j)}_{interaction\ effect}, \quad (21)$$

where $\overline{W} = \overline{PS} + \overline{CS}$, in which $\overline{CS}$, $\overline{PS}$, and $\overline{W}$ show the baseline welfare terms without cost uncertainty.

Since the signs of θ and $Cov(q_i, q_j)$ always go opposite,[7] we introduce an interaction measure to integrate these two cross-effect parameters as follows:

$$Int(q_i, q_j) = -\theta\, Cov(q_i, q_j), \qquad i \neq j. \quad (22)$$

This interaction measure represents the degree of interaction between any pair of firms (i,j), $i \neq j$. Equations (19) ~ (21) can be rewritten in terms of $Int(q_i, q_j)$ as follows:

$$E[PS]-\overline{PS}=-\sum_i \underbrace{[Var(q_i)]}_{\text{variation effect}}+\sum_i \underbrace{Cov(-c_i,q_i)}_{\text{allocation effect}}+\sum_i \underbrace{\sum_{j\neq i} Int(q_i,q_j)}_{\text{interaction effect}}, \quad (23)$$

$$E[CS]-\overline{CS}=\tfrac{1}{2}\sum_i \underbrace{[Var(q_i)]}_{\text{variation effect}}-\tfrac{1}{2}\sum_i \underbrace{\sum_{j\neq i} Int(q_i,q_j)}_{\text{interaction effect}}, \quad (24)$$

$$E[W]-\overline{W}=-\tfrac{1}{2}\sum_i \underbrace{[Var(q_i)]}_{\text{variation effect}}+\sum_i \underbrace{Cov(-c_i,q_i)}_{\text{allocation effect}}+\tfrac{1}{2}\sum_i \underbrace{\sum_{j\neq i} Int(q_i,q_j)}_{\text{interaction effect}}, \quad (25)$$

where the own effect is further decomposed into *variation effect* (on the revenue side) and *allocation effect* (on the cost side).

Next we compare these terms under two information structures — shared information and private information — corresponding to the two scenarios with and without the B2B exchange. The difference of *PS*, *CS*, and *SW* are respectively:

$$\Delta E[PS]=-\sum_i [\Delta Var(q_i)]+\sum_i \Delta Cov(-c_i,q_i)+\sum_i \sum_{j\neq i} \Delta Int(q_i,q_j), \quad (26)$$

$$\Delta E[CS]=\tfrac{1}{2}\sum_i [\Delta Var(q_i)]-\tfrac{1}{2}\sum_i \sum_{j\neq i} \Delta Int(q_i,q_j), \quad (27)$$

$$\Delta E[W]=-\tfrac{1}{2}\sum_i [\Delta Var(q_i)]+\sum_i \Delta Cov(-c_i,q_i)+\tfrac{1}{2}\sum_i \sum_{j\neq i} \Delta Int(q_i,q_j). \quad (28)$$

It becomes clear from equations (26) ~ (28) and (22) that the relative strength of the following four components plays a key role in measuring the welfare of producers, consumers, and the society: (i) $Var(q_i)$, (ii) $Cov(c_i, q_i)$, (iii) $Cov(q_i, q_j)$, and (iv) θ. The first two terms constitute the *own effect*, and the last two constitute the *interaction effect*. By combining these factors, we may have a very useful way of tracing out the welfare effect of information transparency.

First, information aggregation tends to increase the variance of individual output, that is, $\Delta Var(q_i) \geq 0$. In other words, information exchange among

producers tends to increase the variance of each firm's output, as a more flexible adjustment of each firm's production activity is facilitated. From equations (26) ~ (28), increases in variance, *Var* (q_i), will raise consumer surplus but lower producer surplus and social welfare. This is consistent with a well-known theme in the economics literature: in markets with uncertainty, increases in variance raise expected consumer surplus as consumer surplus is a convex function of output (Gal-Or, 1986; Vives, 1984).

Second, information transparency among producers tends to contribute to the efficient allocation of resources across firms in the following sense: the lower-(higher-) cost firms are likely to increase (decrease) their outputs in response to more accurate information about the cost vector, as shown in (8) and (12). That is, information transparency will increase the covariance between ($-c_i$) and q_i, or $\Delta Cov\,(-c_i, q_i) > 0$. Therefore, the mixture of outputs (and market share) is shifted toward more efficient firms in the presence of greater information transparency. This allocation effect is shown to be beneficial to the industry and the society as in (26) and (28), where the benefit arises from a better correspondence between costs and outputs.

Third, comparing these terms inside and outside the B2B exchange, it can be shown that:

$$\Delta Int\,(q_i, q_j) = -\theta\,\Delta Cov\,(q_i, q_j) > 0\,, \qquad i \neq j\,. \tag{29}$$

This means that information transparency tends to reinforce the degree of interaction between the output strategies of the firms. Information transparency tends to make the market *more* "uniform" (increasing the correlation of the firms' strategies). It is clear from equations (26) ~ (28) that higher degree of interaction will benefit producers, but it will make consumers worse off. Intuitively speaking, the interaction among member firms tends to strengthen their cooperation, which helps member firms to form an implicit coalition. The welfare position of consumers as outsiders is weakened. The overall effect on social welfare is still positive, though.

By putting these three effects together and based on (26) ~ (28), albeit a tedious process, we can show the following result:

Proposition 3 (Welfare effects on producers, consumers, and society): Producer surplus will rise due to more efficient allocation of production

quantities. Yet consumer surplus can be higher or lower, depending on the relative strength of the variation effect and the allocation effect. The overall effect on social welfare will be positive.

Proposition 3 suggests that information transparency facilitated by the B2B exchange affect producers and consumers differently. The industry as a whole is better off because the interaction effect and allocation effect together tend to dominate the variation effect. But this benefit is not uniform among individual producers. The high-cost firms will be worse off, because profits will be redistributed from high-cost firms to low-cost firms.

Information exchange among producers may have a rather complicated effect on consumers. It may hurt consumers in some situations, but may benefit them in other situations. $\Delta E[CS]$ may move in either direction, depending on the relative strength of the variation effect and the interaction effect. When goods are moderately substitutable and costs are reasonably correlated (i.e., $\theta > 0$ and $\rho < 1$), information sharing benefits consumers. Otherwise, it is harmful for consumers.

Looking from another angle, the combined forces of such technological and stochastic interactions measure the degree of intermixture of *competition* and *cooperation* among firms. Our model shows that in the Cournot world under cost uncertainty, if the combined interaction is positive and strong (for example, when products are complements) then firms become mutually complementary rather than competitive, as there appears to be much room for cooperation among producers. The result is that cooperation through information aggregation will benefit participating firms, but it may hurt consumers. In this case, the firms' incentives to form the B2B exchange may be socially excessive, and anti-competitive concerns may become legitimate as producers' and consumers' interests collide regarding information transparency of the B2B exchange. Then the FTC's concern might be justified in such a situation (CRN Business Weekly, 2000; Disabatino, 2002).

Comparison with the Literature

To close this section, it is worth noting the differences between our results and the literature. As mentioned earlier, the closest studies to our model might be Shapiro (1986) and Li (1985). Several differences exist between our chapter

and theirs. The differences lay primarily in the information structure, in terms of both the type of information and the mechanism that the information is being transmitted. For example, those papers examined a situation where all firms received the resulting aggregate information. Only anonymous, aggregate statistics of firms' cost data was disclosed. This feature is more representative of a public agency (for example, a census bureau or trade association) than a B2B exchange. By contrast, in our model, cost data at the individual firm level can be inferred from the B2B exchange. It can transmit much deeper firm-specific data about costs than other mechanisms previously available. The different assumptions about the role of the underlying technologies entail different setup of the model, and we show that these different models lead to very different equilibrium outcomes.

As a consequence of this setup, the result was two extreme information-sharing arrangements: either industry-wide complete information pooling or no information sharing at all, as in Shapiro (1986) and Li (1985). We show that these all-or-none scenarios for information sharing can be considered as two special cases of our model, corresponding to $k=n$ and $k = 1$, respectively. In contrast, our model shows a very different result, namely, not all the firms in the industry would prefer to join the exchange. Firms with heterogeneous costs have different incentives for information exchange. Generally speaking, it would not be the case that all firms find beneficial to join the exchange.

There are other differences as well. For example, Shapiro (1986) considered homogeneous products ($\theta = 1$). As a result, information pooling always hurts consumers in his model as well as that of Li (1985), which did not reveal the possibility that information pooling could even be beneficial to consumers in certain situations. This has different implications to the desirability of information exchange.

Finally, the current chapter is an extension to Zhu (2004). While it follows a similar model setup and methodology, there are key distinctions. The current chapter uses a more general demand function, as defined in (1), and extends the Zhu (2004) model to include broader welfare effects. On the other hand, Zhu (2004) considers both quantity competition and price competition, while this current paper considers quantity competition only.

Conclusions

What have we learned about the welfare implications of information transparency? We have found that information transparency affects producers and consumers differently. Although information transparency on the B2B exchange is socially desirable, its private desirability is deeply divided between producers and consumers, and even among producers themselves. Our model shows a conflict between producers' and consumers' interests regarding information transparency of the B2B exchange. Producer surplus may rise because the interaction effect and allocation effect together tend to dominate the variation effect. Concerning the consumer side, there is no allocation effect present, but the interaction effect is operating against the variation effect. Depending which effect dominates, consumers may benefit in some situations but may get hurt in other situations.

Certain types of companies (for example, high-cost suppliers of substitute products) will lack the incentives to join the B2B exchange as information transparency hurts more than helps them. In contrast to the widely held belief about its benefits (the so-called *information transparency hypothesis*), information transparency is indeed a double-edged sword. Our results suggest that the actual effects will be rather complicated — a transparent environment is not necessarily a good thing for all participants. This may partially explain the difficulty of most public B2B exchanges in signing up suppliers (Harris, 2001), and the recent observation that many firms switch from public exchanges to private exchanges (Hoffman et al., 2002), which tend to be less transparent than the public exchanges. For example, Wal-Mart, Cisco, Dell, and Hewlett-Packard have established private exchanges with their suppliers and business partners (Dai & Kauffman, 2002).

Our analysis shows that the welfare effects can be decomposed into two distinct effects — the variation effect on the revenue side and the allocation effect on the cost side. We found that dividing the welfare impact into these two separate effects is quite helpful to trace out the welfare impact. By introducing these new concepts, we point out the possibility that the transparency of cost information can be either beneficial or detrimental to consumers and producers. This highlights one of the differences of our model from the literature.

Thus this chapter provides a theoretical interpretation about the informational effects of B2B exchanges. On the other hand, one has to be careful when linking these results to real-world B2B exchanges. There are many reasons for firms to join a B2B exchange. The informational effects are just one, albeit an important one, of these many factors. Our model focuses on just one aspect of the informational effects induced by the B2B exchange — information transparency about costs. So the propositions and conclusions about welfare effects must be conditioned on this partial-equilibrium setting and the standard ceteris peribus assumptions under which they have been derived.

This paper can be extended in several directions. Informational effects can be multi-dimensional. We only modeled the horizontal information effects among competitors. We have not considered vertical information exchange between suppliers and manufacturers in a more general supply chain collaboration environment (Lee & Whang, 2000; Plice, Gurbaxani, & Zhu 2003). Many of these issues, especially information transparency in online supply chain collaboration, deserve further research. Second, an extension of the current model might consider double-sided externalities in a neutral marketplace, where the buyer side and seller side influence each other. Third, it might be interesting to consider firms' participation in multiple exchanges (Belleflamme, 1998). This is another fertile area for further research. We hope that the initial work presented in this chapter will motivate other researchers to build more sophisticated models and further examine the multiple dimensions of informational effects associated with electronic markets.

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Endnotes

1 We cite several B2B exchanges throughout this chapter just to illustrate our points, rather than advocating or criticizing these exchanges. They were in existence at the time of writing of this work, but some of them might go out of business in the future, partly due to the transparency issues identified in this research.

2 Cost transparency is increasing on all sorts of electronic markets. On eBay, data about bidding prices, quantity, winning bids, and seller identity are all visible on its auction Web site, which started as a business-to-consumer market but also conducts business-to-business transactions as small- and medium-sized companies turn to eBay for procurement. As yet another example from our daily life, detailed breakdowns of invoice prices of new cars are now readily available on the Internet; car dealers are no longer able to hide their cost data

3 For reference, see Grossman (1981), Jordan and Radner (1982), Novshek and Sonnenschein (1982), and Shapiro (1986).

4 Uncertainty about *costs* is different from uncertainty about *demand*. Cost is a technology-based, firm-specific *private* parameter, while demand is a parameter *common* to all market participants. From a modeling perspective, the distinction lies in the source of stochastic disturbance. In the case of demand, all the firms face a common disturbance in their demand functions. In the case of cost, there are as many sources of idiosyncratic disturbances as the number of firms, with each source being associated with one firm.

5 Portions reprinted, with permission, from Kevin Zhu, "Economic Implications of B2B Electronic Markets: The Private and Social Desirability of Information Transparency," presented at the *37th Hawaii International Conference on System Sciences*, © 2004 IEEE.

6 In order to isolate the informational role of B2B exchange, we assume that there is no other credible channel for rivals to exchange cost data. For example, unilateral announcement would not be credible and hence cannot serve as an information exchange mechanism. To avoid further complication, we assume there is only one B2B exchange in this industry and firms operate in one market only. For simplicity, we ignore the cost of joining the B2B exchange.

7 If products are substitutes (that is, $\theta > 0$), then firms' reaction curves are negatively sloping, so that the covariance of any two outputs must be negative (i.e., $Cov(q_i,q_j) < 0$ for $i \neq j$). On the other hand, if products are complements, namely $\theta < 0$, then firms' reaction curves are positively sloping, therefore $Cov(q_i,q_j) > 0$.

Chapter III

Partnering for Perfection:
An Economics Perspective on B2B Electronic Market Strategic Alliances

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Abstract

New technological innovations have made it possible for new intermediaries to create value in business processes that involve the procurement of manufacturing and services supplies. Associated with these innovations is the emergence of business-to-business (B2B) electronic markets. These act as digital intermediaries that aim to reduce the transaction costs and mitigate the risks inherent in procurement. They improve buyers' capabilities to search for attractive prices and also serve to increase the liquidity of sellers' products. In this chapter, the authors explore the evolution of B2B e-market firms in terms of the strategies they employ to "perfect" their value propositions and business processes for the firms.

This is a critical aspect of their attractiveness as business partners for the buyers and sellers that participate in their electronic marketplaces. The key theoretical perspectives of this work are adapted from economics and strategic management. They enable the authors to construct a "partnering for perfection" theory of strategic alliances in e-procurement markets. This perspective is captured in a series of inquiries about "why" and "when" B2B e-markets are observed to form alliances. The authors carry out an innovative econometric analysis that delivers empirical results to show the efficacy of the theory in interpreting real world events. The chapter concludes with a discussion of the implications of this work in academic and managerial terms.

Introduction

Business-to-business electronic markets proliferated in the mid to late 1990s with the widespread application of the Internet and World Wide Web to inter-firm transactions. By the middle of 2000, there were about 1,500 B2B marketplaces in the United States, according to the estimates of Deloitte Consulting (2000). However this boom turned into a bust in early 2001, when many B2B exchanges either shut down or were acquired. Recent estimates suggest that there are only about 150 surviving B2B e-markets (Day, Fein & Ruppersberger, 2003).

B2B E-Market Firms: Evolution and Transformation on Internet Time

All the changes that we have seen reflect the intense competition that has unfolded in the arena of B2B e-commerce. In this environment firms that operated e-markets made great efforts to develop and adapt their business models and strategies to meet the competition, while the landscape of digital procurement also rapidly evolved out of their control. The earliest e-market firms followed in the footsteps of their business-to-consumer (B2C) counterparts to build Web sites with e-catalogs and search functions. They also created public marketplaces where buyers and suppliers could exchange product and price information with low transactions costs.

Later on, having observed and participated in the public B2B exchanges, buyers and suppliers entered into this area with their own online marketplaces. In some industries, firms combined their efforts and resources to operate a shared platform on which they could buy or sell products via the Internet. For example, the major automobile manufacturers, including General Motors, Daimler Chrysler, Ford, Nissan, and Renault (later to be joined by Peugoet-Citroen) formed Covisint. This provided an industry-wide electronic marketplace connecting firms so that they could buy and sell parts and supplies more cheaply. Another approach that firms took is to develop private exchanges to conduct transactions online with their selected customers or suppliers, like what Wal-Mart has done. At the same time, third-party B2B e-market firms that pioneered public exchanges developed functions to meet the demands for private transactions and collaboration between firms that are participating in their online marketplaces.

We define a B2B e-market firm as an independent firm or a subsidiary of a firm that hosts and operates Internet and Web-based information systems by which other firms can purchase and sell products. As a form of business organization, B2B e-market firms present themselves as transformational information technology (IT) firms. On the one hand, they are IT firms because they use computer and telecommunication technologies to produce the products and services that they offer. Their products and services are inseparable from the development, design, and operation of computer systems and telecommunication networks. On the other hand, they differ from traditional IT firms in that their offerings are completely built upon the Internet and Web technologies instead of legacy systems. Most of them have been recognized as new entrants in the IT industry and as explorers in the arena of new business models and strategies.

As technology solution providers, B2B e-market firms offer an innovative form of interorganizational information systems (IOS), utilizing the Internet and Web technologies to provide shared infrastructure and a means for commercial exchange. They typically offer electronic product catalogs, price discovery mechanisms, and other market-making functions. In addition, they provide new procurement and distribution channels for firms that manufacture or consume the products that are transacted in their online marketplaces.

Challenges of B2B E-Markets

During their evolution, B2B e-market firms have typically been owned by third-party firms or sponsored by industry consortia. They have faced a number of

challenges that have stemmed from the characteristics of the market segment in which they operated and the nature of the technologies upon which they built their business. First, as new ventures in the digital economy, B2B e-market firms have faced the challenges that all new organizations have to conquer. The managers and employees of newly-formed organizations have to accumulate skills and knowledge about operating the business, understand the market and effectively invest in technology (Stinchcombe, 1965). Young firms need to develop stable linkages with key stakeholders and enhance their external legitimacy. In addition new organizations typically are small and do not have the financial and other resources to withstand a sustained period of poor performance. In our context, in order to serve buyers and suppliers in particular industries, B2B e-market firms had to rapidly learn about the inter-firm transaction processes in these industries and to gain recognition for the quality and effectiveness of their services and products among potential customers. They also need to obtain approval and endorsement from venture capitalists so as to secure financial resources.

In addition to the challenges of being new and small, B2B e-market firms also have had to tackle the various challenges and risks that the fast-growing market and evolving technologies bring about. Although high-growth markets generate opportunities and potential rewards, they also present high risks due to market uncertainties and rapid technological changes. Aaker and Day (1986) point out that high-growth markets are often overcrowded with competitors, so that newly-entering firms will lack the resources to maintain a similarly high rate of growth. At the same time, the rapid technological development increases the level of uncertainty and enables later entrants to leapfrog with a superior product or with a low-cost advantage. This description characterizes the situation in the market for the procurement services offered by B2B e-market firms. Despite the fact that the number of B2B e-marketplaces rose dramatically from about 300 in 1998 to 1,500 in 2000 (Deloitte Consulting, 2000), this rapid growth inevitably intensified the competition in the young market for e-procurement services, squeezing the marginal players. Most of these firms took advantage of the willingness of venture capitalists to provide financing, but, all too soon, this rapid growth would lead to tightening financial constraints and the recognition by the venture capitalists that they had been badly fooled by the "hype." Moreover, innovative technologies and applications, such as Web services, have continued to flow into the market, giving the later entrants opportunities to jump ahead with cheaper, better, and more effective new technologies.

A third source of challenges that B2B e-market firms faced came from the network effects that characterize the Internet and Web technologies underlying online marketplaces. One critical feature of B2B e-market firms is their ability to utilize the Internet and Web to create communication networks that can connect buyers and suppliers. In other words, what a B2B e-market firm offers can be viewed as a "network product." As can be observed in other markets for network products, the growth of B2B e-markets is subject to network effects that bring about more risks for these new enterprises (Shapiro & Varian, 1999). In the presence of network effects, the first challenge to a B2B e-market is to build up a critical mass of buyers and suppliers for its online marketplace so as to get the momentum for growth. However, early B2B e-market firms had difficulties achieving a critical mass of buyers and suppliers. Buyers were skeptical about the business value of the online marketplaces (Day, Fein, & Ruppersberger, 2003).

The second challenge due to network effects is to develop or adopt technological standards that put the B2B e-market firm in an advantageous position in relation to its competitors. Unfortunately, however, in this area of B2B e-commerce, different specifications of some of the leading technologies still are vying to become the standards. For example, Commerce One, a leading B2B technology provider, has been supporting ebXML, a variant of XML (Extensible Markup Language), which is advocated by the Organization for the Advancement of Structured Information Standards (OASIS). Another major player in this field, Ariba, promotes cXML, its own proprietary version of XML. As a result, there is no guarantee that documents following the different XML specifications can be exchanged easily. So it is not clear which XML specification will win the standards war. Such uncertainties in the competition among potential standards represent another source of technological risks for the growth of B2B e-market firms.

Overall, since the inception of e-commerce, the competitive landscape of B2B e-procurement has changed dramatically, while B2B e-market firms have been adapting to cope with the challenges they have faced. These challenges constitute market and technological risks that threaten these firms' growth and viability. How can they reduce these risks and overcome the various challenges? We argue that one important strategy that B2B e-market firms have employed is to partner with other organizations to reduce these market and technological risks and "perfect" their business processes.

B2B E-Market Firm Strategies

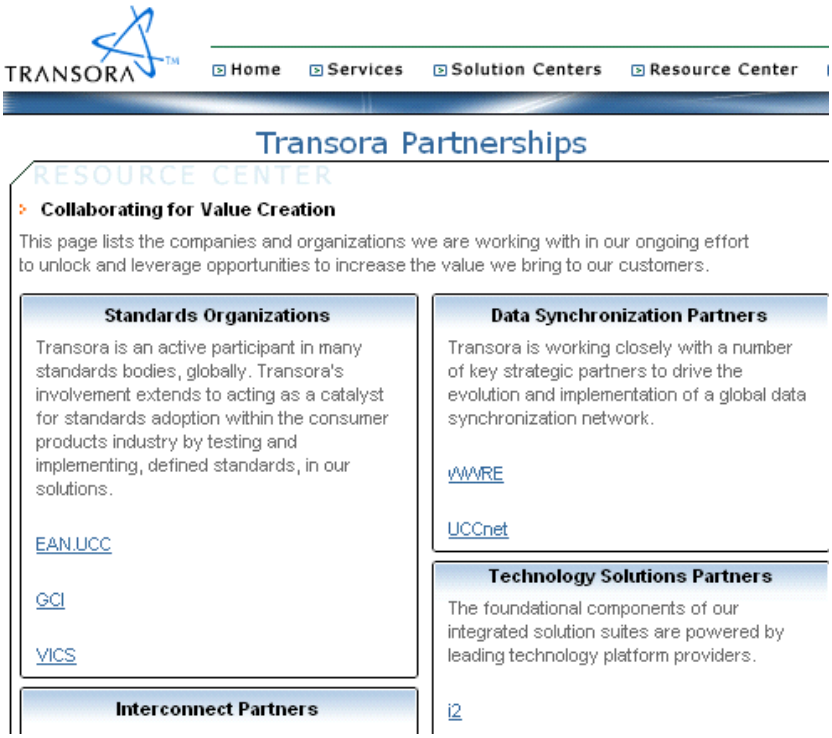
We now turn to a discussion to set up the basis for understanding business process perfection strategies for B2B e-market firms.

Perfecting B2B E-Market Firm Functionality

During the process of evolution and adaptation, B2B e-market firms have gone through three developmental phases to perfect their functions and underlying technologies. According to Bakos (1998) in the early days of B2B e-commerce, B2B e-market firms built virtual marketplaces around their role as digital intermediaries to reduce transaction costs, supporting transaction-making by electronic means all the way from information search through price discovery, and finally to transaction settlement. B2B e-markets compiled product information for many suppliers as e-catalogs so that buyers could do one-stop shopping on the Internet. They also implemented dynamic trading processes to match demand and supply for spot purchase and other transactions in uncertain environments. In addition, they provided facilitation services, including financial services and logistics arrangements that helped firms to close inter-firm transactions. So overall the first impetus of B2B e-market firms was to create virtual marketplaces with the basic market making functions on the Internet. For example, ChemConnect (www.chemconnect.com), a B2B e-market firm in the chemicals industry, was first built as an Internet-based bulletin board for exchanging information about chemical products. Later it launched online auction and negotiation functions to expand its market-making capabilities.

While their role as market makers remains essential for online marketplaces, B2B e-market firms also recognized their second role as interorganizational information systems, and the needs of buyers and suppliers for nurturing their relationships and managing inter-firm business processes. One potential of IOS in this context is to enable innovative interorganizational business processes accompanying their implementation (Truman, 1998). In this way, B2B e-markets have offered platforms to streamline workflows and promote interorganizational collaboration, supporting effective business process management. A typical example is BenefitPoint (www.benefitpoint.com), which operates a Web-based network for insurance distribution and administration. Insurance carriers and their agents can log on to the BenefitPoint system to

Figure 1. Transora's B2B e-market alliance partners



Source: Transora, www.transora.com/repository/en/community/Community partnerships.jhtml (Accessed July 29, 2004)

manage all the activities involved in ordering and renewing underwriting requirements, updating and tracking client data, and so forth. Furthermore, B2B e-markets can also provide functions for collaborative supply chain management by coordinating demand forecasting and production scheduling, as observed in the online platform of Transora (www.transora.com), a B2B e-market that operates in the retailing industry.

As B2B e-market firms serve buyers and suppliers that participate in their online marketplaces, they have been developing their capabilities as technological adapters, extending the connectivity of their trading networks via systems integration, the implementation of technical standards, and IT outsourcing services (Dai & Kauffman, 2002). To reduce the efforts that firms have to take to join their networks, B2B e-market firms provide solutions and services to integrate member firms' back-end enterprise systems with the marketplaces they wish to trade in so that the benefits of participation increase. In addition they implement standards for common data formats and business processes, such as industry-specific XML standards, to enhance the connectivity of their networks. We also see this with Transora's relationships with the EAN Uniform Code Council (global standards group for XML) and the Voluntary Interindustry Commerce Standards (VICS) group (see Figure 2).

Figure 2. Standards organization: EAN.UCC – The Uniform Code Council for XML

Source: Uniform Code Council, www.uc-council.org/ean_ucc_system/ (Accessed July 29, 2004)

Another example is NewView Technologies Inc. (www.newview.com), a marketplace for the steel industry. It created a systems integration solution called "NewView Connect" that is based on the latest XML technology and can be deployed to set up a seamless connection between a firm's back-end system and NewView's Web-based systems.

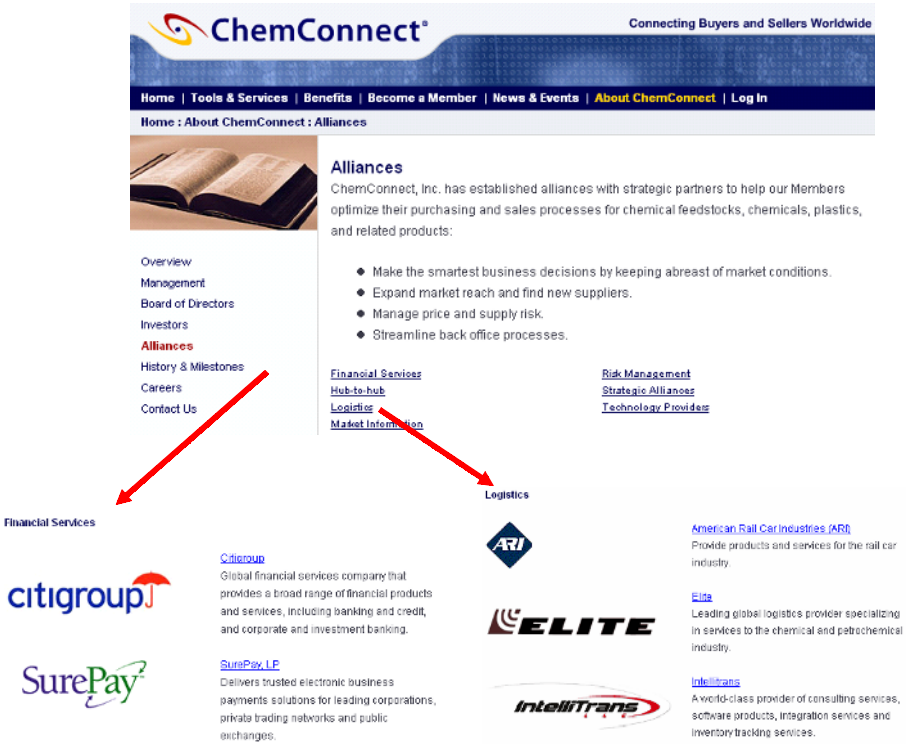
The above discussion shows that as a platform and electronic channel for inter-firm transactions, B2B e-market firms assume roles of market makers, business process facilitators, and technology adapters. Although individual B2B e-market firms may weigh each role differently, the market demand pushes them to aggregate a matrix of functions and capabilities onto a single platform, forming all-in-one markets in which buyers and suppliers can shift between different transacting mechanisms and also streamline business processes (Kambil, Nunes & Wilson, 1999). It is a challenging task to achieve all the functionalities to fulfill these roles, and this task is further complicated by the typical business hazards in the B2B e-markets arena.

Managerial Choices and Alternatives

One way for B2B e-market firms to build up the capabilities for performing these roles is to develop the related functions through internal growth. For example, ChemConnect added auction and negotiation mechanisms into its online marketplace platform through internal development to expand its transaction capabilities (www.chemconnect.com/history.html).However, firms also have found that they need partnerships to leverage external resources to enrich their market's functions through alliances and acquisitions (Segil, 2000). For instance, ChemConnect merged with Envera (previously www.envera.com) to obtain connectivity technologies while partnering with ForestExpress (www.forestexpress.com), a B2B e-market application provider for forest products, to expand the reach of ChemConnect's trading network. The firm uses alliances for financial services, hub-to-hub capabilities, distribution logistics, market information, risk management, core business strategic function, and technology providers (see Figure 3).

The importance and prevalence of alliances in B2B e-procurement are reflected in a study published in the *McKinsey Quarterly*. Ernst, Halevy, Monier, and Sarrazin (2001) reported that as B2B e-markets experience growth and market change, they have found it essential to leverage strategic alliances to gain effective access to products, customers, and new business opportunities.

Figure 3. Chemconnect's financial services and logistics alliances



Source: www.chemconnect.com/alliances.html (Accessed July 29, 2004)

Moreover, Rajgopal, Venkatachalam, and Kotha (2002) found that alliances were a commonly employed strategy among B2B firms and that announcements of strategic alliances generated positive abnormal returns on stocks. The market value of partnerships is also captured in a study that Lenz, Zimmermann, and Heitmann (2002) conducted among European B2B e-markets. Through a field survey, they showed that B2B e-market firms formed alliances to obtain access to resources that will enhance their capabilities in information services, transaction services, and other value-added services. And with partnerships, B2B e-market firms perceived themselves to be more capable and stronger than competitors in offering these services.

By bringing in external skills and resources via alliances (Teece, 1992), B2B e-market firms aim to add new functions or enhance existing functions, perfecting their services and business processes (see Table 1 for examples).

Table 1. B2B e-market firm alliance examples

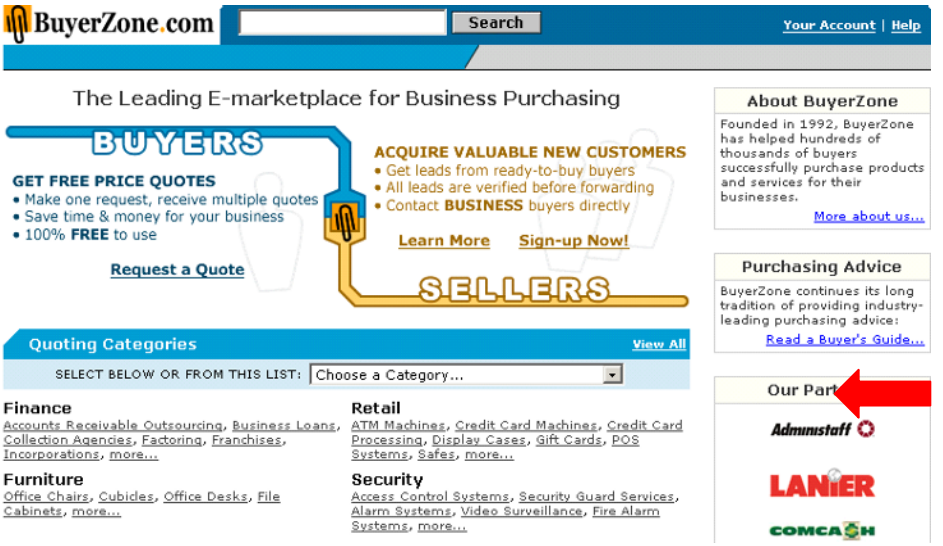
B2B E-MARKET FIRM	START DATE	INDUSTRY, PRODUCT EXCHANGED	STRATEGIC ALLIANCE: PARTNER AND ACTIVITIES	APPARENT RATIONAL FOR STRATEGIC ALLIANCE
Bandwidth.com	1999	Telecommunications, specifically for Internet access	Co-developed match-making service with Byers Engineering	Obtain skills, assets to enhance product, service functionality
BuyerZone.com	1992	Small business, specifically for MRO, IT and office supplies and services	Partnered with AOL to distribute services to AOL users	Send positive signals on product to boost reputation
CheMatch	1995	Chemicals, especially bulk chemicals and plastics	Linked with Chem-Cross to offer users direct access to marketplace	Expand reach of trading network

A typical example is the partnership between Bandwidth.com (www.bandwidth.com), an online marketplace for telecommunications services and other carriers, and the Byers Engineering Company. These two firms jointly developed a matchmaking service that aimed to provide a tool for firms in the telecommunications industry to identify partners in constructing network facilities and infrastructures (PRWeb, 2000). This partnership enables Bandwidth.com to build the new function to expand its offerings.

B2B e-market firms also employ alliances as a means for reducing their market and technology risks. They enter into co-marketing agreements to gain recognition of their capabilities among customers, suppliers, and partners, which reduce risks that they face as new organizations in an emerging industry sector. Buyerzone.com (www.buyerzone.com), a market for small businesses, formed a marketing alliance with America Online to distribute its one-stop shopping services to firms via AOL (BuyerZone.com, 2000). This way the name and reputation of Buyerzone.com was boosted through AOL's distribution channels. Today the firm partners with Minolta, BusinessWeek, Primepay, Artsoft, and Yahoo (see Figure 4).

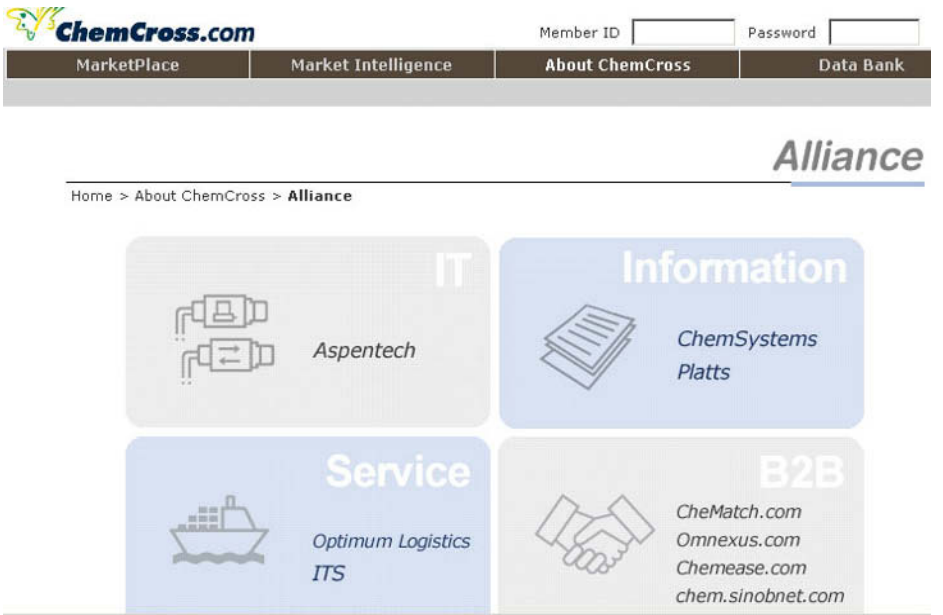
In addition, B2B e-market firms also leverage alliances to promote the connectivity and participation in their trading networks to reduce the risks that originate from the network effects of Internet technologies. For instance, CheMatch.com, a now-defunct Internet-based marketplace in the chemical

Figure 4. Buyerzone.com's alliance partners



Source: The Buyerzone.com, www.buyerzone.com (Accessed July 29, 2004)

Figure 5. ChemCross.com's approach to alliance-making



Source: ChemCross.com, www.chemcross.com/aboutChemcross/CACFr JpAboutChem crossHtmlView.jsp?ACAlliance.html (Accessed July 29, 2004)

industry, formed an alliance with Seoul, South Korea-based ChemCross.com (www.chemcross.com), a chemical e-marketplace, to set up a direct linkage between their systems. For CheMatch this partnership extended the reach of its trading network by bringing Asian chemical companies onto its marketplace through ChemCross. For the former, although it failed, it was a means to build critical mass in participation to leverage the network effects. Meanwhile ChemCross entered into this partnership for the same purpose.

In summary, we see that strategic alliances of various sorts have been an important strategy that B2B e-market firms have leveraged to obtain resources to develop important operating functions and to reduce market and technology risks.

Theoretical Perspectives on Alliances

Strategic alliances are formal cooperative relationships between firms that pool or exchange their resources and share returns from a pooled investment (Teece, 1992). Along with showcasing the efficacy of cooperative strategies among firms that search for partners to improve their competitiveness, the academic literature offers various perspectives that address the issues that arise related to alliances from an economics and strategic management view (Faulkner & de Rond, 2000; Lorange & Roos, 1992).

One benefit of alliances is the access to complementary resources and assets at a lower cost than if they were to develop the capabilities internally; by doing this, partnering firms are able to improve performance (Teece, 1992; Hagedoorn, 1993). The alliance literature recognizes three kinds of critical resources in this context: technical, commercial, and social resources (Ahuja, 2000). Technical resources are the skills and capabilities for developing and offering new products. Commercial resources include firm marketing and distribution skills that can bring products to customers. Social resources reflect the linkages that firms have already formed and can be leveraged to obtain other resources. For example, through an arrangement called "code sharing," the airlines have managed to cooperate with each other on connecting flight routes. This has increased their traffic on the shared routes and has permitted them to gain market share from other airlines (Bamberger, Carlton, & Neumann, 2001). Code sharing can be viewed as a strategy for partnering airlines to tap into each other's distribution channels, an important commercial resource. Alliances also

provide good opportunities for firms to obtain knowledge and know-how that reside within partner organizations, as learning is an important rationale for firms to form partnerships (Mody, 1993). In the biotechnology industry small firms partner with established pharmaceutical companies so that the former obtain access to the market while the latter obtain knowledge in developing new drugs (Lerner & Merges, 1997).

Another function of strategic alliances is to enhance perceptions about a firm in the marketplace by associating it with more well-established partners. Rao and Ruekert (1994) argued that brand alliances act as signals that disseminate information about product quality in the marketplace. Companies can boost reputation and brand identity by marketing together with other well-known brands — something that works especially well for experience goods that have an important unobservable quality (Kirma & Rao, 2000; Rao, Qu & Ruekert, 1999). Not only are perceptions of product quality enhanced, but also firm capabilities will be perceived differently when a strategic alliance has been made. For example, small biotechnology firms send positive signals about their capabilities to prospective investors by partnering with market-leading pharmaceutical firms (Nicholson, Danzon & McCollough, 2002).

Along with obtaining access to external resources and signaling quality to the marketplace, companies can employ alliances to add organizational flexibility and to protect specialized assets under market uncertainty. As a quasi-organizational form, strategic alliances give firms the flexibility of forming and disbanding linkages with partners swiftly in response to changes in demand or other aspects of their business environment (Chan, Kensinger & Keown, 1997; Mody, 1993). Under market uncertainty, firms will seek close longer-term relationships, not arm's-length market transactions, to overcome opportunistic behavior (Williams, 1985). In this way, alliances offer an organizational form that enables firms to obtain assets rapidly and flexibly. Stuart, Hoang, and Hybels (1999) have observed that strategic alliances will be preferred and will create more positive leverage on firm performance when the uncertainty is higher. In addition in the early stages of technology development and commercialization, the high product and market uncertainty makes alliances a preferred strategy for product functionality innovations and product promotion for market acceptance (Roberts & Liu, 2001).

By providing access to resources, enhanced market perceptions and organizational flexibility, strategic alliances enable partnering firms to improve their performance and position in competitive markets, their stakeholder valuations,

product innovations, and long-term survivability. Chan, Kensinger and Keown (1997) found that stock prices responded positively to the formation of alliances and partnering firms displayed better operating performance than their industry peers over a five-year period. The value of alliances is especially plain to see when the partnerships involve the exchange of technological assets and skills (Chan, Kensinger, Keown & Martin, 1999; Hagedoorn & Schakenraad, 1990). Moreover, in high-technology industries, enterprises leverage alliances to enhance their competitiveness. Baum, Calabrese and Silverman (2000) found that new biotechnology firms that formed more alliances and were involved in efficient relationships outperformed other firms in the market for initial public offerings of stock. Stuart (2000) studied the impact of partners' capabilities on a firm's innovativeness and sales growth in the electronics industry and showed that firms enjoyed higher rates of product innovation and sales growth when their partners had a higher level of technological capabilities and revenues.

How B2B E-Market Alliances Assist Firms to Deal with Risks

Based on the above discussion, we identify three types of risks that B2B e-market firms face: their risks as new organizations, the risks of fast-growing markets and technologies, and the risks associated with network effects. We next will discuss why we think that strategic alliances enable B2B e-markets to reduce these risks with the benefits that the alliances bring about.

Why Strategic Alliances Reduce Risks of B2B E-Market Firms

First B2B e-market firms, as new organizations, need to accumulate management skills and establish stable exchange relationships (Stinchcombe, 1965). They must get beyond the novelty of the technology to cope with the difficulties of market acceptance and problems associated with developing the appropriate management resources that constitute a set of risks for the growth and survivability of new firms (Shepherd, Douglas & Shanley, 2000). Building up

external linkages is an effective method to deal with these problems. Why? New firms can learn from their partners about how to manage effectively in a specific industry context, how to gain access to the necessary resources, and how to secure key relationships with customers and suppliers. Moreover, the ability of alliances to send positive signals about product quality and firm capabilities to the marketplace will help B2B e-market firms build reputation and gain recognition among potential customers and suppliers, strengthening their crucial external linkages.

Second B2B e-market firms have been commercializing the Internet and new Web technologies for inter-firm transactions in a high-growth marketplace where demand and technologies have been changing fast. This brings about another set of risks for B2B e-market firms. Aldrich and Fiol (1994) pointed out that in such marketplaces, forming external linkages will enable firms to improve performance. And, at an early stage of technology development, demand uncertainty poses a risk on product development, and innovative product functionality is critical for success (Roberts & Liu, 2001). B2B e-market firms have sought to integrate their capabilities for digital intermediation, the management of interorganizational processes, and technology adaptation to better support buyers and suppliers (Dai & Kauffman, 2002). How can they build effective functionality in the changing marketplace? Strategic alliances provide an available and effective method for alleviating the risks with new product innovations, since firms can utilize their partners' business assets to develop new functionality swiftly and flexibly.

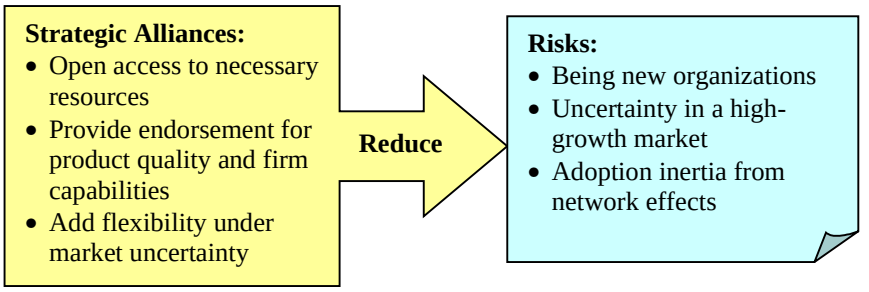
As providers of network products, B2B e-market firms face the challenge of building a critical mass of participants to sustain network growth. Katz and Shapiro (1994) showed that innovative network products fail if they do not gain a sufficient number of adopters. Apparently this is true, even if the intrinsic quality of the products is superior to existing products. They observed that potential adopters demonstrate some reluctance in joining the new networks for fear of losing connections with other users — a source of inertia. To reduce the risk of failure due to adoption inertia, B2B e-market firms can build their functionality and service capabilities on the basis of accepted technology standards. They can also make their networks compatible with other technologies and offer products and services that allow participants to connect and integrate their information systems, so that the switching costs are held in check (Dai & Kauffman, 2002).

Buyers and suppliers must make substantial efforts and must have the resources available to switch trading networks. This often includes changing computer and telecommunications systems, putting new applications into place, and redesigning a number of business procedures. By allying with firms that are potential participants, a B2B e-market firm increases the incentives for participants to make relationship-specific investments and to switch to its network, reducing the risk of network inertia. Alliances will encourage costs and benefits sharing, and follow-on investment from network participants can help to improve network performance (Bakos & Nault, 1997). This will further reduce the risk of failure for B2B e-market firms.

In a world of network products, standardization requires the coordination of suppliers of various components of the network system. For example, in recent years, firms in the IT industry have formed alliances to develop and promote standards for various technologies (Roberts & Liu, 2001). Through partnering with organizations that are providers of the technologies that underlie digital procurement, B2B e-market firms are better able to leverage proprietary technologies for their benefit and to gain favorable support in implementing standards. This way they can reduce the uncertainties that potential adopters face in switching trading networks, which, in turn, has a beneficial effect for reducing any signs of adoption inertia that may threaten B2B e-market growth.

Overall, strategic alliances open favorable access to resources, provide endorsement for product quality and firm capabilities, and add flexibility under uncertain environments. By leveraging alliances, B2B e-market firms are able to reduce the risks of failure (see Figure 6).

Figure 6. Why strategic alliances diminish risks of B2B e-market firms



Theory Development: Explaining B2B E-Market Firms' Strategic Alliances

We next translate these observations into some basic statements of a new theory that is intended to explain why B2B e-market firms form strategic alliances. A starting point is our observation that the higher the risks that B2B e-market firms face, the more likely they will resort to strategic alliances to reduce them. To evaluate this assertion we can identify the situations where B2B e-market firms face high risks vs. relatively low risks. Although all new organizations face the risks of failure, pioneering ventures tend to face higher risks than later entrants (Shepherd, Douglas, & Shanley, 2000). This is because they also have to create the industry or industry sector in addition to their own business. Also, in the formative stages of an industry, external legitimacy is critical. So cooperation with other organizations enables new ventures to gain legitimacy and broad acceptance of their new business models among key stakeholders (Aldrich & Fiol, 1994). As a result, we expect that B2B e-markets that are early entrants will tend to form more alliances than later entrants.

Since the online marketplaces represent new transaction channels for buyers and sellers who do not completely know about how these channels work, the capabilities of B2B e-market firms are often of concern. Firms purchasing online will tend to perceive higher procurement risks compared to the conventional procurement channels (Chircu & Kauffman, 2001). This, in turn, will affect the perceived effectiveness of B2B e-markets in facilitating markets for different procurement needs. In the presence of high-channel uncertainty, firms will be more willing to use B2B e-markets for purchasing indirect products that have low strategic significance (Kauffman & Mohtadi, 2004). Concerns about transparency in e-markets may also make suppliers more cautious about joining (Zhu, 2002). They would like to avoid price competition.

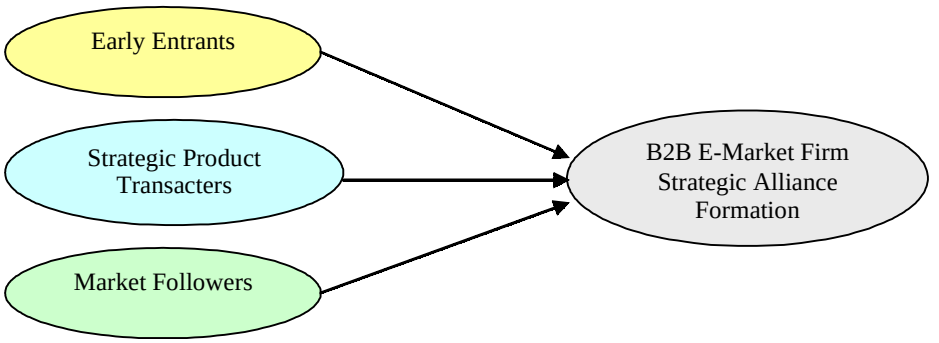
The above studies suggest that buyers and suppliers are likely to view online markets as a riskier channel for transacting strategic products or exchanging complex specifications and strategic information. To buyers, strategic products are those that will have direct and significant impacts on the production of their final goods and their market positions. Baily (1987) identifies five types of business purchasing requirements: merchandise for resale; parts and material for production; maintenance, repair, and operating supplies; plant and equipment; and services, such as maintenance of equipment and cleaning. The first two categories of products provide the basic inputs for final products, so they

are strategic products. Another type of strategic product that is not included in Baily's categories is business services, including financial and marketing services that are essential for executing a company's strategies.

The key point is that most firms tend to view B2B e-markets as a riskier channel for procurement (Kauffman & Mohtadi, 2004) and may wish to avoid purchasing strategic products through online marketplaces. As a result, B2B e-market firms will face more challenges to achieve critical mass adoption when they are serving buyers and suppliers who are involved in large-scale or strategic transactions or products. When this is the case, we argue, e-market firms will have greater incentive to search for external support to signal their service quality and firm capabilities. This will lead B2B e-markets that deliver strategic products to buyers to form more alliances than those that are involved in non-strategic products.

The competitive position of a B2B e-market firm in the marketplace is also a predictor of the formation of strategic alliances, in our view. Market followers are not as resourceful as the leaders with regard to managerial skills and technological and financial support. They are at a disadvantage to the competition and face higher risks of failure. To catch up with the leaders rapidly they are more likely to leverage alliances to obtain necessary resources from partners. So B2B e-markets that are market followers ought to form more alliances than market leaders. These observations are summed up in Figure 7.

Figure 7. Player types that drive B2B e-market firm alliance formation



Data Collection and Variables

B2B E-Market Firm Strategic Alliance Formation

We next present an overview of data collection, measurement issues, and description for the variables in the study that we will use to test the theory discussed earlier.

Data Collection

We collected data from Thomson Financial's (www.tfn.com) Joint Venture/Strategic Alliances database. This database provides "one-stop" information about alliances from multiple sources, including SEC filings, trade publications, and international and national newswire sources.

Data Set and Unit of Observation

For the period from January 1995 to February 2002, we retrieved 6,241 entries of alliances in which at least one participant had an e-commerce business line or where alliances were reported in the e-commerce area. We then filtered these according to the business descriptions of partnering firms to select alliance announcements with at least one participating firm being a B2B e-market firm. We also supplemented the Thomson Financial data with Lexis-Nexis (www.lexisnexis.com) information on the same alliance announcements and retained those data with entries in both databases. Finally, we collected 319 alliance entries, involving 193 different B2B e-market firms.

Then we incorporated B2B e-market firms that were listed in *Forbes* magazine's B2B Web site directories but were not reported to have formed alliances, adding another 136 firms. As a result, in total, there are 329 B2B e-market firms in our data set. Among these 329 firms, just 94 were listed as "Best-of-the-Web" B2B e-markets by *Forbes*. Our unit of observation is a strategic alliance event initiated by a business establishment and accompanied by an identifiable announcement or news item that describes the alliance. A business establishment can be a firm, branch, or firm subsidiary.

Identification of B2B E-Market and Partner Firm Characteristics

We compiled data from various sources to identify and evaluate relevant characteristics of B2B e-markets. For publicly traded firms we collected data from the Mergent FIS online database (www.fisonline.com). For privately held firms we used company Web sites, Lexis-Nexis, and the United States Patent and Trademark Office's Trademark Electronic Search System (tess.uspto.gov). We coded the characteristics of B2B e-markets and partnering firms.

Variables

We identified and coded a set of variables for B2B e-market firm characteristics and product characteristics. The variable names and definitions are shown in Table 2.

Table 2. Variable definitions

VARIABLES	DEFINITIONS
#Alliances	Total number of alliances that a B2B e-market formed during period of study, January 1995 to February 2002
MktLeader	Binary variable for market leader, based on Forbes' "Best-of-the-Web" B2B directories for 2000 and 2001 (www.forbes.com/bow/)
VerticalExch	Binary variable for B2B e-market firm serving a specific industry or a specific business function, which defines it as a "vertical exchange"
ConsortExch	Binary variable for B2B e-market sponsored by industry consortium.
EarlyEntrant	Binary variable for whether B2B e-market founded by 1998, and is an early entrant
DigitalSvcs	Binary variable for whether product transacted is digital business services or information products
MROSvcs	Binary variable for whether B2B e-market firm transacts MRO products
DirectGoods	Binary variable for whether buyers in e-market purchase raw materials, parts, and components for their manufacturing and production processes
ResaleGoods	Binary variable for whether B2B e-market has buyers who purchase goods for resale to consumers
CapitalEquip	Binary variable for firms in e-market that buy/sell capital equipment
OtherGoods	Binary variable for firms that see other goods or product types
StrategicProd	Binary variable to indicate that goods transacted are strategic products to buyers; includes business services, direct goods, or resale goods
Note: We use many binary variable codings, to indicate the presence or absence of various characteristics. The binary variable codings do not always indicate exclusive categorizations of what a B2B e-market does in its business. Instead, a firm may have a number of characteristics that are taken from among a group of variables. This permits us to include binary variables without specifying a "base case."	

Several comments on the variable definitions are appropriate. A report from Deloitte Consulting (2000) showed that new B2B e-markets came into the marketplace gradually from 1995 to 1998, and then the number of new B2B e-markets increased rapidly in 1999 and 2000. The Dow Jones Internet Index (www.djindexes.com/jsp/internetIndexes.jsp/) also reached a new high at the end of 1998. So B2B e-markets that were in operation by 1998 can be viewed as early entrants. Among the product types that we identified in the table, MROSvcs and CapitalEquip are non-strategic products to buyers. In contrast, DirectGoods, ResaleGoods, and DigitalSvcs are strategic products because these products directly affect the product and service quality of the buyers. Therefore, we also define the binary variable, StrategicProd, to represent the case where goods transacted on the B2B e-market are direct goods, business services, and/or resale goods.

Data Set Description

In our data set, there are 329 B2B e-market firms, of which 160, or 48.6%, are market leaders that are listed in *Forbes'* "Best-of-the-Web" directories (www.forbes.com/bow/). The majority, 78% of the B2B e-markets, are vertical exchanges. Many B2B e-markets serve more than one product type, including business services and digital products (97 firms), direct products (161 firms), resale goods (48 firms), MRO and office supply services (45 firms), and capital equipment (24 firms).

In total, we identified 319 bilateral strategic alliance events in our data set distributed across the years 1998 to 2002, as shown in Table 3. There are 63 instances out of the total 319 alliances that involved equity investments or exclusive agreements. In 141 cases B2B e-market firms formed alliances with Internet firms; in seven instances they partnered with trade associations; and in the remaining 171 cases they had conventional firms as partners. Among these 171 cases, in 15 instances B2B e-market firms partnered with traditional intermediaries, such as distributors.

Table 3. Distribution of bilateral strategic alliances announcements by year

YEAR	1998	1999	2000	2001	2002	TOTAL
Number of Strategic Alliance Events	4	22	215	73	5	319

Empirical Models, Analysis, and Results

We next present three different models — an ordinary least squares model, a Poisson count data regression model, and a negative binomial regression model — to analyze strategic alliance formation related to the theory we laid out earlier in this chapter. We coded #Alliances as the dependent variable, and our unit of analysis is the B2B e-market firm.

Ordinary Least Squares (OLS) Model

We first estimate an OLS model with our data as in the following equation:

$$\#Alliances = \beta_0 + \beta_1 * MktLeader + \beta_2 * VerticalExch + \beta_3 * StrategicProd + \beta_4 * EarlyEntrant + \beta_5 * ConsortExch \quad (1)$$

The estimation results are summarized in Table 4.

The OLS estimation results show a negative coefficient on the variable MktLeader. This indicates that market-leading B2B e-market firms tend to form fewer alliances than market followers. The positive coefficient of the

Table 4. OLS estimation results

Variable	OLS Model Coefficient (Standard Error)
Constant	1.117 (0.229)***
MktLeader	-0.401 (0.149)***
VerticalExch	-0.879 (0.195)***
StrategicProd	0.625 (0.243)***
EarlyEntrant	0.630 (0.157)***
ConsortExch	0.018 (0.245)
Note: Model R^2 = 11.5%. Degrees of freedom = 323. Significant at 0.01 level ***, 0.05 **, 0.1 *. Number of observations = 329.	

variable EarlyEntrant tells us that the earlier a B2B e-market firm entered the marketplace, the more alliances it has tended to form. Similarly, the positive coefficient of StrategicProd means that B2B e-market firms for strategic products have formed more partnerships than others. Taken together these results support our explanations of the observed patterns of strategic alliance formation among B2B e-market firms. However the reader should note that the OLS model estimation results assume a continuous dependent variable, which is an approximation to the bounded count data that we have in this research setting. As a result, the OLS regression is only an approximation (similar to the use of OLS to estimate continuous market shares between 0% and 100%). #Alliances can be thought of as a discrete count variable, with a lower bound of 0 and an upper bound of 12 in our data set. To capture this in the dependent variable, we estimate a Poisson regression model.

Poisson Count Data Regression (PCDR) Model

In our B2B e-market context, strategic alliance announcements are events that occur discretely and infrequently, leading to a limited-dependent count variable.

Limited-Dependent Count Variables

There are numerous models that can effectively deal with limited-dependent variables (Maddala, 1983), among which the Poisson count data regression (PCDR) model is appropriate in situations where the dependent variable is a count or frequency of occurrence and large counts are rare (Cameron & Trivedi, 1986; Winkelmann & Zimmermann, 1995). In our context instances of strategic alliances can be assumed to occur independently, and the total number of strategic alliances that a firm forms indicates the combined effects of its motivation and opportunities to employ partnering strategies. As a result, it is appropriate to assume that the occurrence of discrete alliance announcement events follows a Poisson distribution, and hence the PCDR model turns to out be an appropriate test approach. That is, the distribution of the number of alliances is represented as:

$$\Pr(Y = y_i) = \frac{e^{-\lambda_i} \lambda_i^{y_i}}{y_i!} \quad (2)$$

where y_i is the number of alliances (#Alliances) that a B2B e-market firm *i* formed during the sample period. In the above expression, λ_i generally is a log-linear link function of explanatory variables with $\log\lambda_i = \beta' X_i$. X_i is the vector of explanatory variables for firm *i*'s alliance choices and the β's are the estimation parameters. In our context, we have selected explanatory variables in the vector X_i for the different characteristics of B2B e-market firms and represent the link function in the following equation.

$$\begin{aligned} \log \lambda_i = \beta_0 + \beta_1 * MktLeader + \beta_2 * VerticalExch + \beta_3 * Strategic\,\Pr od \\ + \beta_4 * EarlyEntrant + \beta_5 * ConsortExch \end{aligned} \quad (3)$$

Based on the theoretical interpretation that we offered earlier, we expect to observe positive coefficients for the following explanatory variables: EarlyEntrant and StrategicProd. However, we expect to see a negative coefficient for MktLeader.

Empirical Model Checks

We checked for problems with pair-wise correlations between all the explanatory variables, none of which cross the frequently used threshold of 0.6 suggested by Kennedy (1998). To detect multicollinearity among the explanatory variables, we also calculated variance inflation factors (VIFs) (Neter, Kutner, Nachtsheim, & Wasserman, 1996) and found that there were no VIFs in excess of 10 that would be a cause for being concerned about multicollinearity.

PCDR Results

We fit our data using the PCDR model in Equation 2 with the explanatory variables that are included in Equation 3 and summarize the results in Table 5 (the middle column). As expected, our results show positive coefficients for StrategicProd and EarlyEntrant and a negative coefficient for MktLeader.

Table 5. Estimation results for B2B e-markets strategic alliance formation

VARIABLE	PCDR MODEL Coeff (Std Error)	NEGATIVE BINOMIAL Coeff (Std Error)
Constant	0.020 (0.168)	0.021 (0.298)
MktLeader	-0.409 (0.115)***	-0.421 (0.135)***
VerticalExch	-0.718 (0.126)***	-0.696 (0.144)***
StrategicProd	0.512 (0.175)***	0.502 (0.304)*
EarlyEntrant	0.580 (0.114)***	0.578 (0.138)***
ConsortExch	-0.010 (0.222)	-0.021 (0.230)
α *(overdispersion parameter)*		0.333 (0.100)***
Model Fit		
Log-likelihood	-441.55	-430.16
χ^2 (degrees of freedom)	66.26 (5)***	22.78 (1)***
Note: Significant at 0.01 level ***, 0.05 **, 0.1 *. Number of observations: 329.		

In general, Poisson regression assumes equidispersion (Cameron & Trivedi, 1998). This means that the conditional mean given by $E[y_i | X_i] = \exp(\beta' X_i)$ equals the conditional variance, $Var(y_i | X_i)$. This assumption implies that the expected value of the event count, y_i, changes only with the explanatory variables. A failure of the assumption of equidispersion has similar qualitative consequences to a failure of the assumption of homoskedasticity in OLS regression. The standard errors of the estimated model parameters will be large so that the estimation will be inefficient. We present the results of a PCDR model that assumes equidisperson as a baseline for understanding the information that econometric analysis can provide in this context. Next we evaluate the equidispersion assumption and discuss the test results.

Negative Binomial Regression (NBR) Model

In evaluating the equidispersion assumption we found evidence to suggest that the null hypothesis of equidispersion, $Var(y_i) = X_i$, fails to hold for our data.

Diagnosing the Equidispersion Problem

To make this check, we conducted the regression-based test on overdispersion as discussed by Cameron and Trivedi (1990). The test evaluates two alternative hypotheses: H_0: $Var[y_i] = \lambda_i$ and H_1: $Var[y_i] = \lambda_i + \alpha g(\lambda_i)$.

Under equidispersion $\{y-E[y]\}^2-E[y]$ should have a mean value of zero, and hence the coefficient α should be zero in $\alpha g(\lambda_i)$. In our context, we used λ_i^2 for $g(\lambda_i)$ and found that the coefficient α is significantly different from 0 by our estimates, which rejects the equidispersion hypothesis. (See Table 5, right column. The estimated value of α = 0.333, with standard error = 0.100, significant at the .01 level.)

NBR Model Results

To account for the overdispersion, we estimated a negative binomial regression (NBR) model that incorporates the possibility of error term heterogeneity into the PCDR model (Greene, 2000). The maximum likelihood estimation results of the NBR model are reported in the right column in Table 5. The χ^2 for the Poisson model shows the difference of the log-likelihood of the estimated model and the model with only the intercept. The χ^2 of the NBR model is based on the difference of the log likelihood of it and the PCDR model. It tells us that the former is an improvement over the latter. As a result, we can use the NBR model estimates to explain the effects of the explanatory variables. The reader should compare the PCDR and NBR results (that is, the middle column results with the right column results). We note that although we rejected the equidispersion hypothesis, the NBR model results do not greatly differ in the signs of their coefficients or their absolute magnitudes. In particular, the negative coefficient on the MktLeader variable is retained, as are the positive coefficients on the StrategicProd and EarlyEntrant variables.

The NBR model estimation results show that EarlyEntrant (0.578, std. error = 0.138, $p < 0.001$) has a significant positive association with the number of alliances that B2B e-markets form. This supports our claim that B2B e-markets that were founded in the early years of e- commerce era have tended to form more partnerships than later entrants. Apparently first movers in this marketplace may have more motivation to seek partnerships or greater capabilities to attract other firms to form strategic alliances. The coefficient on StrategicProd (0.502, std. error = 0.304, $p<0.1$) is also positive and weakly significant. This is consistent with the prediction of the theory we cited earlier: B2B e-markets that trade strategic products are more likely to employ alliances. Finally, based on our estimate of the MktLeader variable in the NBR model with a significant negative coefficient (-0.421, std. error = 0.135, $p < 0.001$), we see that market leaders are observed to have fewer strategic alliances than market followers.

Table 6. Estimation results with different product types

VARIABLE	NEGATIVE BINOMIAL I Coeff (Std Error)	NEGATIVE BINOMIAL II Coeff (Std Error)
Constant	0.021 (0.298)	-0.011 (0.257)
MktLeader	-0.421 (0.135)***	-0.400 (0.156)***
VerticalExch	-0.696 (0.144)***	-0.707 (0.166)***
StrategicProd	0.502 (0.304)*	
EarlyEntrant	0.578 (0.138)***	0.593 (0.140)***
ConsortExch	-0.021 (0.230)	-0.057 (0.229)
DirectGoods		0.514 (0.201)***
ResaleGoods		0.500 (0.254)**
DigitalSvcs		0.488 (0.208)**
CapitalEquip		-0.030 (0.232)
MROSvcs		-0.078 (0.263)
Log-likelihood	-430.16	-427.22
Note: Significant at 0.01 level ***, 0.05 **, 0.1 *. Number of observations: 329.		

In order to further understand the patterns of alliance formation by B2B e-market firms, we next include in the negative binomial model the variables for the product characteristics that B2B e-market firms trade. The estimation results are summarized in Table 6. The middle column repeats the results in the third column of Table 5, and the third column shows the results with the five different product types.

With these five variables for product types included instead of the binary variable StrategicProd, our results show that the effects of other variables in the model have little change. Among the five variables representing the five product types, DirectGoods, ResaleGoods, and DigitalSvcs have significant positive associations with #Alliances, while CapitalEquip and MROSvcs have a very weak negative association. This indicates that B2B e-market firms that trade direct goods, resale goods, or business services tend to form more alliances. Meanwhile our results are inconclusive as to whether B2B e-market firms for capital equipment and MRO products and services are less likely to enter into partnerships.

Discussion

Primary Managerial Insights

Our empirical investigation of the partnerships that B2B e-markets have formed offers insights about the formation of B2B e-market alliances, and the analysis results from the OLS, PCDR, and NBR models support our argument that B2B e-market firms form partnerships to reduce the risks of failure. We find that early entrants and market followers in the arena of B2B e-markets tend to use partnerships more frequently than later entrants and market leaders. Also B2B e-markets that transact strategic products employ alliances more frequently than those for non-strategic products. Apparently B2B e-market firms look for partnerships when they believe they are facing higher risks.

Our results raise an interesting point regarding how different types of B2B e-market firms use partnerships. Vertical e-markets tend to have fewer alliances, as indicated by the estimated negative coefficient of VerticalExch (-0.696, std. error = 0.144, $p < 0.001$). Our tentative explanation is that vertical e-markets are focused on specific industries, and thus they have a more restricted scope for developing cooperation and partnerships. Another reason may be that vertical exchanges perform in a more predicable environment than horizontal exchanges — their market niches involve somewhat less risk because they are more narrowly defined. Specifically, to the extent that industry-specific exchanges accumulate their knowledge about this industry, they are better able to handle the market uncertainty, and so they have a diminished need for external resources.

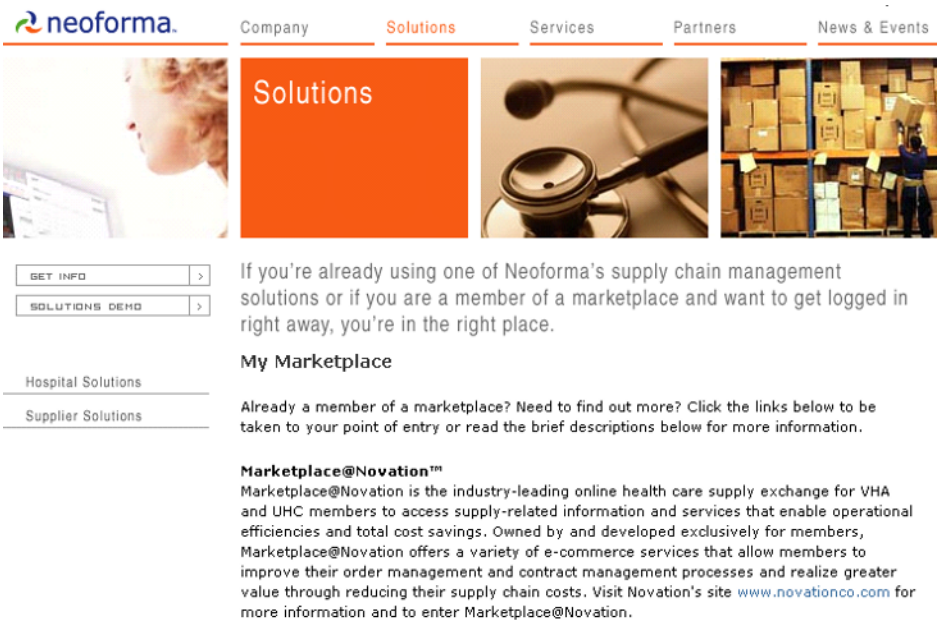
We also note that industry consortium-sponsored B2B e-markets do not perform differently from other third-party operated firms in the formation of alliances, since the coefficient of variable ConsortExch is insignificant in all the above models. These firms entered the marketplace later because they were established after their founding firms had observed the operation of other B2B e-markets. In addition, they are often perceived to be market leaders since they are backed up by influential firms in particular industries with financial resources and managerial skills. These two characteristics indicate that industry-consortium-sponsored B2B e-market firms probably faced lower risks than their counterparts operated by third-party firms. As a result, our logic tells us that they ought to form fewer alliances. But we observed no strong effect for ConsortExch, positive or negative. An appropriate next step is to look into the

alliance strategies of industry consortium-sponsored B2B e-market firms to gain a better modeling understanding.

Secondary Managerial Insights

Our study brings three managerial issues into focus. First, strategic alliances appear to impact the evolution and adaptation of B2B e-market firms. Through their alliances, B2B e-markets have the capability to change their strategic direction and reposition themselves to meet market demand. For example, in the healthcare industry, Neoforma (www.neoforma.com) started as a neutral B2B electronic market to offer public exchanges. Later on, it re-positioned itself to provide platforms for private exchanges. This strategic redirection was completed through an alliance with Novation (www.novationco.com) that is a purchasing organization and offers an industry-wide e-market (Figure 8).

Figure 8. Alliance-based repositioning strategy involving neoforma and novation



Source: www.neoforma.com/corp/solutions/my_marketplace.html (Accessed July 29, 2004)

Second, alliances offer incumbent firms opportunities to enter into B2B procurement services arena by taking a "short-cut". They face the usual difficulties that startups face, especially the lack of knowledge about the technologies and market. Through strategic alliances they can gain access to the technology skills and organizational assets with far less effort and without repeating the mistakes that pioneer firms typically make. Strategic alliances, at the same time, enable incumbent firms to learn about new technology and new business practices from the startups. They also create real options to acquire their startup partners if the joint ventures surpass financial expectations (Kogut, 1991). For example, during 2000, the enterprise software provider SAP (www.sap.com) allied with Commerce One (www.commerceone.com), a B2B e-markets systems solutions startup, to co-develop and co-market a comprehensive software suite for e-procurement business process automation (Boudette, 2000). One year later SAP exercised this real option to increase its commitment to this relationship and completed an acquisition of Commerce One (Boudette, 2001).

The third issue is related to the inter-firm relationships and ownerships that these alliances impact. When B2B e-market firms partner with buyers and suppliers to overcome adoption inertia, they typically include buyers and suppliers of their online marketplaces in sharing the IT investments, the gains, and the responsibility for decision making about market functionality and operating policies. In some cases these partnerships may involve rivals in their particular product markets. So it is important to investigate how B2B e-market firms structure alliances and balance power among partners to obtain effective results from these partnerships.

Limitations and Future Directions

Limitations of the Data Set

In our data set some B2B e-market firms were able to go public and, as a result, achieved more visibility and access to funds than other firms. This may have affected their opportunities in forming alliances and even their performance. In future research we plan to look more closely at whether publicly held and privately held B2B e-market firms exhibit different strategic alliance patterns. Another factor that may influence the performance of B2B e-market firms is the

venture funds that they obtained from the capital market. In future research we will try to control for the effects of more abundant and more limited venture capital funding. Due to limitations on the availability of data we were not able to explore the financial performance of B2B e-markets. Most of them are privately held and so data about financial performance, such as annual revenues or sales, are not available.

Future Research Directions

The results of this study open some other avenues for future research as well. First, since alliances help reduce risks of failure, forming alliances should tend to improve the performance of B2B e-market firms. In a market that has experienced a shakeout, an examination of the effects of alliance formation on firm performance, and particularly the viability of B2B e-market firms, will provide rich knowledge about what worked and what did not. Second, the results of our study may be applicable in other industrial sectors where interorganizational linkages and cooperation play an important role in alleviating market and technology risks. One such sector is the digital mobile phone technology and services industry, which is greatly affected by network effects and has seen high growth.

Third, we have ignored the differences among strategic alliances and focused entirely on the total number of alliances. Clearly, not all B2B e-market strategic alliances were created equal. The heterogeneous risks that B2B e-market firms face originated from various sources, so their partnerships were built for various purposes. Some alliances were formed for co-marketing; others were developed to build new business functionality. It would be interesting to conduct a more refined study of the formation and effects of the different kinds of alliances by B2B e-market firms. In addition, our analysis is based on firm-level data that is aggregated over the whole period of time of the study. We may be able to create additional insights about B2B e-markets' alliance strategies if we are able to disaggregate the data over time and study the path- dependent changes of alliances.

Contributions

B2B e-market firms have competed in the past several years in a rapidly changing market, where demand is uncertain and the technology continues to evolve. The nature of their services as trading and exchange networks has created unique challenges for them to achieve acceptance in their industry marketplaces. To cope with the various risks of failure, B2B e-market firms have sought allies that can provide complementary resources to perfect their business processes and core functionality, boost their market reputation, and add flexibility in product innovation. Our research presents preliminary empirical evidence for the employment of strategic alliances as a risk-reducing strategy. We find that the more risks they face, the more alliances that B2B e-market firms form. We characterize this overall strategy as one of "partnering for perfection" in business process capabilities.

This chapter contributes to the literature in electronic markets through an empirical investigation of the strategies of B2B e-market firms by revealing how they employ cooperative approaches. This work also adds to what we know about alliance strategy formation by examining relevant theories in the context of emerging and dynamic B2B e-markets. The main message of our study is that alliances help reduce risks. Thus firms will be more likely to seek partnerships when the market and the technology risks they face are higher. This research will form an important basis for future research that aims to provide deeper insights on the efficacy of industrial practices in assessing the value of alliance strategies under various business conditions.

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Chapter IV

Transparency Strategy in Internet-Based Selling

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Abstract

Internet-based selling offers firms many new opportunities regarding the strategies for design of mechanisms to support consumer transactions. This chapter examines the use of transparency as a strategy for Internet-based selling for maximizing firms' value from their selling activities on the World Wide Web. We define transparency as the extent to which a seller reveals private information to the consumer and explore three of its most often observed dimensions: product, price, and supplier transparency. We evaluate consumers' responses to each kind of transparency in terms of their willingness-to-pay. We position the theory in the context of the online air travel industry to showcase its applicability and the power of its

theoretical insights in an appropriate real world context. We also generalize our findings to suggest some managerial guidelines that will help managers who want to make choices regarding transparency strategy in other Internet-related business contexts.

Introduction

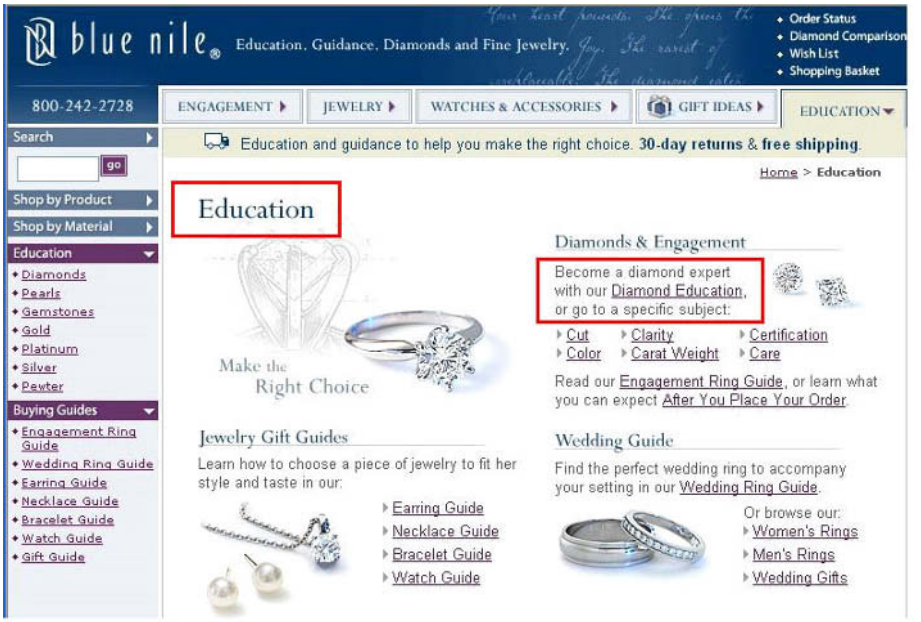
The World Wide Web has changed the business environment and competitive behavior in many industries because consumers now have more access to market information. The speed at which the Internet has revolutionized information availability and information sharing has taken managers by surprise. While many firms have failed in their effort to implement sound Internet strategies in an environment where consumers are better informed, other firms with creative strategies have succeeded. Blue Nile (www.bluenile.com), a small online jewelry store, for example, increased sales from $14 million to $72 million over the last five years by educating male consumers in the purchase of an engagement ring (Acohido, 2003) (Figure 1). Also eBay (www.ebay.com) intermediated the trade of items worth $15 billion in 2002, of which 97% were sold by small businesses or individuals. eBay's strategy is based on the premise of providing equal access to auctioneers, resulting in neutral product offers to consumers (Hansell, 2003). Orbitz (www.orbitz.com), the airline industry consortium online travel Web site, became the market leader in the sale of airline tickets just two years after its launch in 2001 and has staked a claim as the most unbiased travel Web site (Granados, Gupta & Kauffman, 2003b).

We will argue that each of these firms has chosen a strategy — known as the *level of market transparency* — involving the revelation of private information to the consumer that sets their business approach apart, forming the basis for a unique value proposition. Successful strategies such as these have been the exception in Internet-based selling.

We establish a foundation for researchers and managers to develop theories and guidelines to strategize around the well-recognized increase in market information available to consumers. We discuss the following questions:

- What is the impact of Internet technology on consumers' access to information?

Figure 1. Choosing a diamond at BlueNile.com



Source: www.bluenile.com (Accessed April 6, 2004)

- What transparency strategies are available to firms in Internet-based selling?
- Can normative guidelines be developed to support a firm's transparency strategy decision?

We define *market transparency* as the availability and accessibility of information, classified in three categories of information that may influence the economic behavior of market participants: price, product, and supplier information. We will discuss each of these categories in greater depth later in this chapter. Different types of information may induce different economic behavior on the part of consumers. To understand the impact of a firm's decision to reveal information to consumers, a certain *level of specificity* about the information itself is necessary. Prior research in financial markets commonly models the availability of specific information to determine how market transparency increases market efficiency or the liquidity of stocks that are

traded. Pagano and Roell (1996) analyze the availability of information on quantities demanded and supplied and its impact on market structure and efficiency. Biais (1993) takes buyer and seller quotes as indicators of market transparency.

In the context of Internet-based selling, there is a need to specify the kind of information that is provided to the consumer to assess his or her response to such information. As a result, we need to think through what level of specificity is appropriate to analyze the information that firms choose to reveal or conceal from consumers. We will argue that firms that use the Internet as a distribution channel should develop a *transparency strategy*. We introduce the concept of *market transparency potential* to show why the Internet has increased the ability of firms to inform consumers. This increased potential is the upper limit of the *market transparency space*, or the set of available options for firms to select a transparency strategy. We provide guidelines that firms can use to develop transparency strategies for Internet-based selling.

The rest of this chapter is organized as follows. The next section grounds the problem in the real-world scenario of online travel agencies (OTAs) that we believe have implemented different transparency strategies. Then we introduce a conceptualization of market transparency, including a definition that is appropriate for this context. Thereafter, we discuss the impact of market transparency on consumers' willingness-to-pay and the strategic implications for firms. Finally, we use the theory that we have developed and discussed in the previous sections to analyze the above questions in the context of the OTA industry. We conclude with a review of the primary contributions of this research and some remaining issues and considerations.

Transparency Strategy: Case Study of the Online Travel Industry

Internet technology has increased the flexibility to provide information to consumers. With simple changes in the design of a Web site, firms can choose to reveal or conceal specific information. This has dramatically increased the strategies a firm can adopt in Internet-based selling. We explore the OTA industry to illustrate transparency strategies in a real-world context. We focus on the strategies that airline firms in the United States have adopted to enter the

OTA market with several new selling mechanisms that exhibit different levels of market transparency. We also incorporate current research and literature that helps interpret the related business problems.

Transparency Strategies in the OTA Industry

We have been conducting exploratory research in an ongoing field study of OTAs and their information revelation strategies on the World Wide Web to inform our thinking about the transparency strategies that these firms are using. A preliminary observation is that firms typically have the opportunity to implement transparency strategies using a multi-dimensional approach. They don't need to just focus on a single aspect (for example, revealing price changes over time). We identify product features, price information, and supplier-related information that can be revealed or concealed, based on the choices that a firm can make about how it wishes to position itself and its products or services in the market.

Product and Supplier Transparency Strategies

A good starting point for this discussion is the airline travel industry in the United States. OTAs have emerged with novel selling mechanisms and different levels of perceived transparency by consumers who have adopted the Internet channel. Of course, we often see airline ticketing Web sites owned by individual airlines (e.g., American Airlines, www.americanairlines.com, America West Airlines, www.americawest.com, Delta Airlines, www.delta.com, and Northwest Airlines, www.nwa.com). However, a number of major airlines have joined forces to launch two new OTAs that make the role of transparency strategy in the OTA clear in terms of the kinds of information that is selectively offered and held back, the positioning of the firms in the marketplace relative to consumers, and what such transparency strategy plays suggest to other firms.

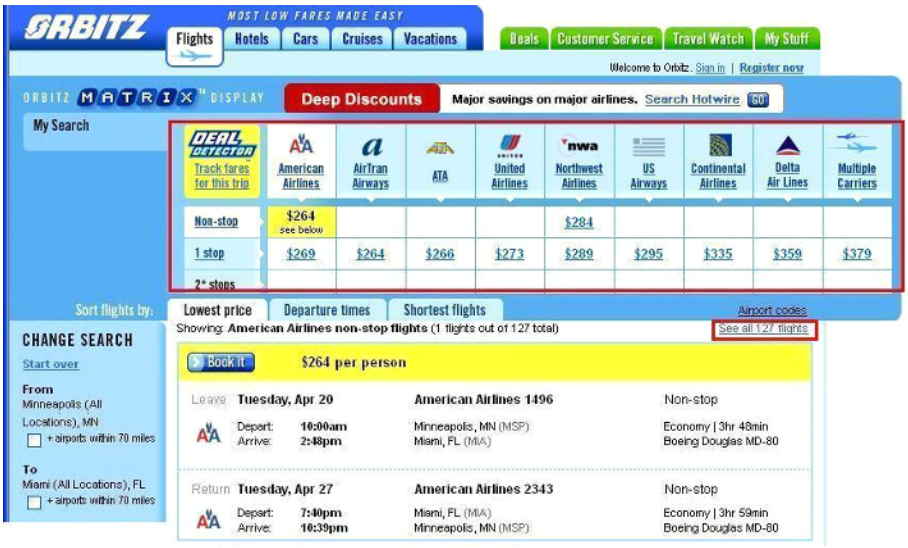
The first is Orbitz (www.orbitz.com), a consortium-owned OTA with involvement from American, Continental, Delta, Northwest, and United Airlines. Orbitz illustrates the general recognition that the marketplaces need centrally located electronic markets that work well on behalf of most of the large competitors. Other organizational forms would be too expensive for any single player, which may not survive in the equilibrium. Orbitz provides multiple combinations of itineraries, airlines, and low fares available based on a

consumer's reservation request. The strategy here is to provide full information to the consumer regarding product and price offers. Figure 2 shows the layout of the information to the traveler in a *matrix display*. It provides a single-screen summary of the available options and avoids the need to scroll down.

This matrix display contains hypermedia buttons to access travel itineraries of interest to the customer, such as options with the lowest prices or airline-specific alternatives. An enabler of this strategy is a state-of-the-art technology that operates behind the scenes, allowing consumers to obtain pass-through, low-cost access to airline itineraries and fares. This avoids limitations of the legacy systems associated with the *global distribution systems* (GDS) firms (for example, Worldspan, www.worldspan.com, and Galileo International, www.galileo.com).

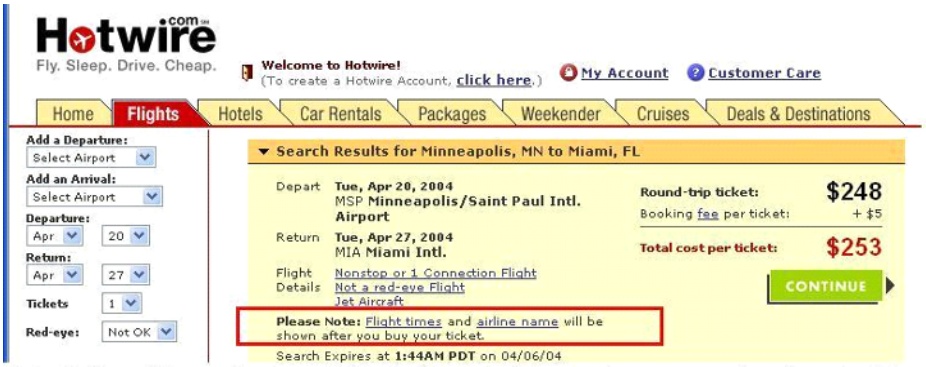
The second OTA is Hotwire (www.hotwire.com), launched by the Texas Pacific Group and six major American airlines (American, Continental, Delta, Northwest, United, and U.S. Airways) in 2000. It has a different transparency

Figure 2. Orbitz's matrix display as an indicator of market transparency



Note: In the selling mechanism of Orbitz (www.orbitz.com), the matrix display is a one-screen summary of the travel options available by airline, price, and number of stops. It conveys the main details of the travel arrangements for which consumers are willing to pay. (Accessed April 6, 2004)

Figure 3. Hotwire's selling mechanism is purposely opaque



Note: In the selling mechanism of Hotwire (www.hotwire.com), consumers do not receive itinerary details and the airline name until the purchase transaction has been completed. (Accessed April 6, 2004)

strategy but does not quite match Priceline.com's (www.priceline.com) market position. Hotwire conceals the name of the airline and the itinerary for a flight until after a consumer completes a purchase. Hotwire also offers lower fares to compensate the consumer for the non-disclosure of this information (Figure 3).

With the launch of these two Web sites, the airlines have effectively segmented the market by providing lower-than-average fares to consumers who are indifferent about the airline they fly and the times when they travel. Those who value this information will search for fares on Web sites, such as Orbitz's or an airline's portal, but should expect to have to pay a premium relative to what Hotwire can offer most of the time. The speed with which the airlines have succeeded in penetrating the OTA market is also notable. We mentioned earlier that it took Orbitz just two years to become the market share leader in its category. Likewise, Hotwire has surpassed Priceline.com (www.priceline.com) in sales to low-end, price-sensitive air travelers who are willing to shop for bargain fares on these less-transparent Web sites (Mannes, 2003).

These developments raise interesting questions regarding the appropriate transparency strategies a firm can adopt to release product and supplier information to the consumer.

Price Transparency Strategies

Priceline.com is at the low end of the transparency spectrum. It conceals the airline name, itinerary, and price until the consumer makes a contract-binding bid. In addition to the explicit concealment of product information, Priceline.com's sales mechanism is also intended to conceal information about the bidding process, which could guide consumers in the process of discovering the market price and his or her willingness-to-pay. The mechanism resembles a sealed-bid auction mechanism. Consumers are required to submit one bid for an airline ticket, but they do not have any information about bids for the same travel itinerary. Only after the traveler has committed to pay and if the bid is accepted, the traveler will receive the airline name and the trip details such as flight times and stopovers (Figure 4). Priceline.com further illustrates that the information signals that the OTA offers to the consumer depend on the design of the trading mechanism. Different kinds of information will be selectively disclosed or held back. This is analogous to the concept of *market microstructure*.

Figure 4. Selling mechanism of Priceline.com

Note: In the selling mechanism of Priceline.com (www.priceline.com), consumers bid for an airline ticket with few indications about the product contents, other than origin and destination.

Market microstructure specifies the characteristics of an *exchange mechanism* that facilitate the *price discovery process* by buyers and sellers (Domowitz, 1995). It also specifies the *information disclosure policies* that may determine the attractiveness and long-run viabilities of an exchange (Biais, 1993; Madhavan, 1996; Pagano & Roell, 1996). The finance literature on market microstructure studies the *level of market transparency*, which defines how much information is disclosed about the trading process (Madhavan, 2000). Examples of relevant market information in this context include the bid-ask spread (the quotes from buyers, sellers, and intermediaries), order flow (net orders to buy and sell, which reflect demand and supply pressures), and transaction history (past transaction quantities and prices). This kind of information is essential and most useful for the price discovery process that market traders engage in. Overall the literature in this area focuses on the *price transparency* dimension.

Zhu (2004) models price transparency in business-to-business (B2B) electronic markets. He finds that sellers who are at a cost disadvantage relative to their competitors will tend to stay away from electronic marketplaces. His results suggest that the disclosure of price information not only creates price transparency but also *cost transparency* (also referred to by Sinha, 2000). The latter is an indication of what inferences can be made by buyers about the cost structure of the sellers.

A Theoretical Framework for Market Transparency

Although much of the existing market transparency literature has concentrated on the impact of price transparency on market structure, efficiency, and liquidity, our field study of the OTA industry suggests that a more complete picture is needed in the context of Internet-based selling. We believe that developing theoretical frameworks that aid our analysis of transparency strategies in Internet-based selling will be of significant use to senior managers. In addition, academic researchers will be interested in the implications for effective strategic positioning on the Internet. We now present some of our current thinking about the key concepts and background for a new theory-based framework to understand the impact of the Internet on market transparency and the alternative transparency strategies firms can employ.

Distinguishing Among Product, Price and Supplier Transparency

Product Transparency

Product transparency exists when the characteristics of the product from a supplier or suppliers are made available. Availability of information about product characteristics is very important to a consumer. Most consumers expect to see this kind of information before committing to make a purchase (Johnson & Levin, 1985). In the Internet environment, consumers use product information to maximize such goals in their purchasing activities as product quality, comfort of the purchasing process, and the integrity of the acquired product (Keeney, 1999). In the OTA industry, a transparent selling mechanism, such as the one offered by Orbitz, provides all itineraries and carriers for a given trip request by a consumer. Embedded in this information will be the characteristics of the product offered, such as service quality, number of stops, layover times, and other factors.

Price Transparency

Price transparency exists when information about the trading goods and transaction process are made available, such as quotes and transaction prices. Price transparency helps a consumer assess the price at which a seller and other consumers are willing to trade, which in turn determines a consumer's willingness-to-pay. When making purchases over the Internet, consumers use pricing information to minimize cost, effort, and time spent (Keeney, 1999). The finance and market microstructure literature suggests that the level of price transparency can be understood by analyzing the mechanism that is used for trading. Generally, the more dynamic the trading mechanism (for example, an auction mechanism), the higher the level of price transparency. A transparent pricing mechanism permits consumers to better assess the reservation price of sellers and other consumers, as well as supply and demand forces.

In Priceline.com's selling mechanism, price transparency is low because consumers are only able to bid once and they are not aware of how much other bidders are willing to pay for the same product, or the volume of competitive bids that Priceline.com has received. In contrast, eBay offers an online auction with a dynamic trading mechanism that is novel for many settings where auctions

were not possible in the past. These include low-liquidity items such as used clothing. Today, aided by the Internet, consumers can view pictures of the product, make online bids, and track the bidding process electronically. The amount of information that they have has dramatically increased, improving the transactability for low-liquidity items. In addition, bidders can make multiple bids until the auction expires. Collectibles (for example, baseball cards, porcelain dolls, rare comic books, and so forth) are made more transactable in the same way.

Supplier Transparency

Supplier transparency refers to the availability of information about suppliers, such as identity, inventory information, shipping costs, and on-time delivery performance. *Supplier identity* provides clues about product or service quality and motivation that the seller has for trading or selling it. A supplier's reputation is a key piece of information that most buyers believe can help them to make a decision about whether it is appropriate to enter into a transaction with the seller. On the other hand, *inventory information* provides clues about the opportunity costs and the likely reservation prices of the supplier. *Cost transparency*, as we previously noted, also provides clues about the seller's reservation price.

Notice that our transparency strategy categories distinguish between product and other types of information. We recognize the diversity in the information needs of consumers that must be met by the seller to make the consumer willing to purchase. For example, with luxury items consumers may be most interested in product characteristics, while in other scenarios such as commodity markets, market price information is more relevant information to make a purchase decision (Bakos, 1997). Related research deals with how consumers think about buying on the Internet and their *information foraging behavior* (Hahn & Kauffman, 2002).

Market Transparency Potential

To understand technology-driven changes in market transparency, it is important to acknowledge that technology itself does not cause these changes; it is the market participants that enable this technology for information revelation and trading. Therefore, market participants make conscious choices to reveal

or conceal information when they decide (individually or jointly) to implement a technology. Nevertheless, technology creates the potential for market transparency to exist. We define *market transparency potential* as the closest point to full transparency that can be achieved in a given market setting.

The United States airline industry, as we have already suggested, is a case in point. Prior to the Internet era airlines and travel agencies used electronic systems called computer reservations systems (CRSs) to share information about product offers and prices offered by the airlines. This information was used to inform consumers about available options for travel, as well as support the completion of purchase transactions. Consumers had little access to this information and depended on physical travel agencies to get it. With the advent of Internet's Web browser technology, OTA electronic intermediaries emerged to extract information from the CRSs and offer it to consumers. They provided consumers of air travel services with a way to complete their purchase transactions electronically. The airlines soon reacted by developing online travel portals offering their products (Granados et al., 2003b).

Market transparency potential depends on the distribution channel and technology used to sell or trade a product. Different channels (and within channels different technologies) can be distinguished by the different levels of market transparency that are possible. Our analysis focuses on transparency in technology-driven channels, where electronic trading and electronic communication prevail. Internet-based selling is especially interesting because it offers firms the opportunity to implement different kinds of transparency strategies that provide them with high flexibility to adapt to different kinds of market environments.

Regarding product transparency, the more digital the characteristics of a product (up to the point where the product becomes a pure information product), the higher the potential for product transparency when the product is traded electronically (Lal & Sarvary, 1999). We observe that goods with digital characteristics typically will have a higher market transparency potential. For example, airline tickets (even though the airplane and the seats that carry travelers from origin to destination are physical) are information-based products. This is true for movie tickets, rental cars, and hotel bookings too. They can be described electronically better than other goods (for example, food, clothes, or tax consulting services).

Most goods have a combination of digital and non-digital characteristics, but the higher the degree of digital characteristics, the higher the potential for product transparency in electronic markets. Subramani and Walden (2001)

have observed that Internet firms that announce new strategic initiatives tend to achieve abnormally higher short-term returns when their initiatives involve digital goods. Kauffman and Wang (2003) have shown that Internet firms are also more likely to survive when they pursue strategies involving the sale of digital goods rather than physical ones or when they act as electronic intermediaries. Conversely, the greater the extent of non-digital characteristics, the higher the potential to sell the product in channels where physical inspection or live demonstrations are possible and create value for the consumer. Subramani and Walden (2001) and Kauffman and Wang (2003) note the lower market valuation and lower rate of survival of this kind of Internet firm.

The literature on financial market microstructure suggests that market mechanisms that generate more information about a trading process have a higher potential for price transparency. Furthermore, the more dynamic the trading process, the higher the potential for price transparency. *Static markets* are those where a firm publishes prices and changes occur as relatively discrete and sometimes even fairly rare events. *Dynamic markets* have prices that change constantly based on demand-supply pressures, such as in double auctions, where both buyers and sellers can influence transaction prices for a single trade. With some exceptions, the more dynamic the process of price setting in a market, the more information related to prices is potentially available to its participants.

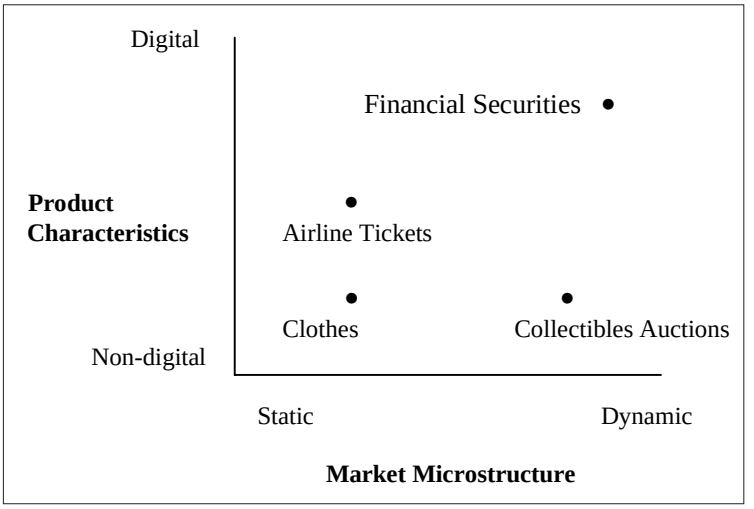
We propose a framework that classifies market transparency potential on the Internet based on product characteristics and market microstructure (Figure 5).

Industries can be positioned in this framework based on the product characteristics and the trading mechanism. This approximates the industry's market transparency potential overall. For example, at the low end are tangible goods such as food and clothes, which by their nature cannot be easily described in the Internet (for example, how they taste or how they feel to the touch). At the high end of market transparency potential are financial securities, information goods that commonly are traded in dynamic markets such as auction or dealer markets.

Market Transparency Strategy Space

Electronic market and Internet-based selling technologies have not only increased the market transparency potential in many industries but also have

Figure 5. Market transparency potential in electronic markets on the Internet



Note: The higher the digital characteristics of the product, the higher the product transparency potential. Also, the more dynamic the market mechanism, the higher the price transparency potential. Firms will be unable to make choices of transparency strategies that have a greater degree of price or product transparency in Internet-based selling than the combination that characterizes an industry's market transparency potential.

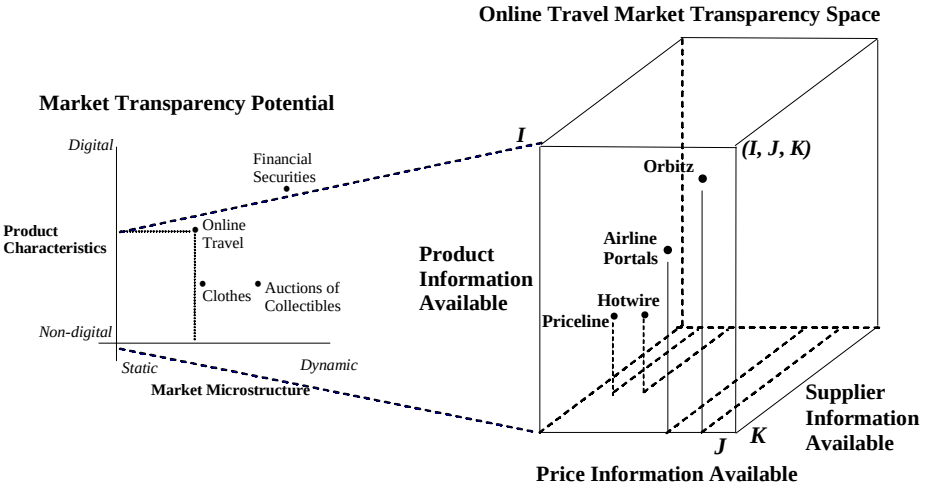
expanded the possible set of strategic alternatives possessed by firms. Before the Internet era, most firms were subject to market structure and transaction-making mechanisms that were not able to bear as much market transparency potential. In the airline industry, the dominant channel for making airline ticket reservations involved legacy CRS technologies at physical travel agencies. Today, however, firms in many industries firms can now select the level of market transparency with which they will compete. In terms of the framework in Figure 5, firms are able to select almost any point in the space *inside* the market transparency potential of the respective industry. By "inside," we mean points that are either below or to the left of any industry's product transparency-price transparency combination that defines its market transparency potential, or both.

The representation of this concept is what we call a *market transparency space*. By adding the supplier transparency dimension that we discussed to this

space, we form a three-dimensional space of transparency strategies that a firm can adopt. Figure 6 illustrates the market transparency space for Internet-based selling in the case of airline tickets.

Assume that a firm selects a specific *transparency strategy tuple* (*i*, *j*, *k*) within the market transparency space (Product Information Available, Price Information Available, Supplier Information Available). In this transparency strategy tuple, *i*, *j* and *k* represent the transparency levels of each of the elements in the product, price, and supplier transparency set that are available, respectively, based on the market transparency potential, (*I*, *J*, *K*), where *I*, *J*, *K* are the product, price, and supplier *transparency potential* levels, respectively, and $0 \le i \le I$, $0 \le j \le J$ and $0 \le k \le K$. A firm should select the market transparency tuple that maximizes profit. This is where the analysis of consumers' responses to market transparency matters. A wrong assumption about the value of information for consumers may result in the wrong strategy for the firm. Likewise, a pricing strategy that does not fit with the market transparency strategy selected may result in sub-optimal revenues.

Figure 6. Market transparency space for OTAs and airline ticket distribution



Note: The market transparency space is the area in the rectangle below and to the left of the market transparency potential. Here, I, J, and K indicate the maximum level of product, price, and supplier transparency, respectively. The transparency strategy tuple (I, J, K) identifies the market transparency potential. The location of each OTA type in this graph is based on relative market transparency positions, so the coordinates are ordinal rather than cardinal.

As reflected in Figure 6, different types of OTAs can be placed in a market transparency space relative to each other. In the market transparency space of the OTA industry, Orbitz has positioned itself closest to the market transparency potential. We determine this through our evaluation of its matrix display, which offers complete product, supplier, and price information. Below Orbitz in market transparency are the airline portals, which offer fewer travel options, limited only to those of the portal site airline and its code-sharing partners. Priceline.com and Hotwire exhibit the lowest levels of product transparency. They both fall short in supplier transparency because, prior to the consumer's purchase transaction, they conceal the airline name. Priceline is to the left of Hotwire in the market transparency space because it conceals all price information until the consumer completes the purchase, while Hotwire shows some prices.

Our definition of market transparency fits the strategy choice problem that firms face about whether to reveal or conceal information in Internet-based selling. We offered definitions for three different types of market transparency: product transparency, price transparency, and supplier transparency. We introduced the concept of market transparency potential to illustrate how electronic markets tend to increase the maximum level of market transparency that is available to sellers. We also introduced the idea of a market transparency space. We characterized this as all the possible transparency strategies a firm can adopt, bounded by the maximum or potential for a specific kind of transparency in an industry. This is due to the nature of its products and its mercantile exchange mechanisms. Our conceptualization sets the stage for researchers to achieve a more complete understanding of transparency strategy.

Transparency Strategies in Internet-Based Selling

In this section we will use the theoretical foundations presented in the last section to develop guidelines for firm adoption of an appropriate transparency strategy. In the presence of information asymmetry, sellers are uncertain about consumers' willingness-to-pay. Different forms of market transparency can influence consumers' willingness-to-pay and the implications for a firm's

strategy choice of market transparency with respect to the market transparency tuple.

Are Consumers Willing to Pay for Market Transparency?

An increase in market transparency is associated with a decrease in the costs of information search and, consequently, it also tends to increase consumers' willingness-to-pay. The rationale is as follows. When firms use electronic markets to disclose information to consumers, in effect they are saving consumers the cost of discovering or finding this information on their own. This results in higher consumer surplus (Bakos, 1997). We call this the *direct effect* of market transparency on consumer surplus. In addition, there are also *indirect effects* on consumer surplus related to the incremental benefits of receiving new market information. Hence, increased expectations of surplus on the part of consumers will result in higher levels of willingness-to-pay. We explore this rationale in more detail below in the context of product, price, and supplier transparency. Table 1 summarizes our analysis.

Table 1. Impact of market transparency on consumers' willingness-to-pay (WTP)

Market Transparency Type	Increases WTP	Decreases WTP
Product transparency	X	
Price transparency		X
Supplier transparency		
❑ Identity	X	
❑ Inventory		X
❑ Cost		X

Note: Empirical research is necessary to determine whether consumers do, in fact, respond to increased levels of market transparency in the ways that we describe here. Nevertheless, the point is this: by understanding the way in which willingness-to-pay is influenced by changes in market transparency, firms will be in a better position to decide what the best market transparency strategy may be to maximize profits.

Product Transparency and Willingness-to-Pay

Product transparency can have an impact on willingness-to-pay in two other ways: direct and indirect effects. In addition to the search cost benefits, product transparency allows the consumer to discern product benefits and shortcomings with higher precision, which may result in more accurate product valuation by the consumer (Harbrouck, 1995). Akerlof's (1970) well-known parable of the *market for lemons* illustrates how an increase in product transparency can increase consumer surplus. Akerlof showed that a market for a product may fail if customers are less informed about product characteristics and quality than suppliers. Hence, the opposite also applies. If consumers are aware of product quality, their surplus ought to increase.

The impact of product transparency on willingness- to pay in Internet-based selling is well illustrated by the OTA example. In the fare search shown in Figure 2, Orbitz offers 233 different itineraries for a reservation request for a round trip between Minneapolis and San Francisco. Because Orbitz offers more information about alternatives for travel, consumers will utilize this Web site to search for information to reduce their search costs, a direct effect. However, this does not necessarily mean that the consumer will purchase the ticket from Orbitz. Consumers may only search Orbitz for a point of reference on fares and travel options, and then purchase their tickets at another Web site or even through a physical travel agency. This kind of consumer behavior is characterized in aggregate by the OTA industry's *look-to-book ratio*. This is a measure of the percentage of people who visit a travel Web site of the total who make a purchase transaction. (For more information on this increasingly standard measure for Web site effectiveness, see Blue Square Studios at www.bluesquarestudios.com/def_looktobook.html)

Orbitz lists specific itineraries for the travel options offered while Hotwire and Priceline.com do not, as illustrated by Figures 2 through 4. A consumer who values information about the itinerary may be willing to pay a premium when purchasing on Orbitz in order to find a better match to his or her travel needs. This is an illustration of the indirect effect. Notice that the indirect effect of market transparency tends to induce purchase more so than the direct effect because it provides incremental value to the consumer beyond the reduction of search costs. In the OTA industry the direct effect of product transparency gives consumers the incentive to perform multi-Web site and multi-channel search before purchasing an airline ticket. Industry research has found that 70% to 90% of air travelers search more than one Web site before purchasing a

Table 2. Normative guidelines for price-market transparency strategies

SCENARIO	GUIDELINES
Product transparency affects market size in terms of base demand	The price ratio between competing firms should equal their market share ratio
Product transparency decreases price elasticity of demand	Two firms should price so their market shares equate
Both of the above	The price ratio of the two firms should equal the square of their market share ratio

Note: This table is adapted from Granados, Gupta and Kauffman (2003a). The assumptions that underlie the model that produced these findings are as follows: two firms, perfect competition, linear demand, short-term horizon, and low marginal costs.

ticket (Forrester, 1999; Regan, 2001). In addition Nielsen Net Ratings (2001) reported that for every dollar in online sales, OTAs stimulated another 68 cents in purchases by phone, fax, or in person.

Granados, Gupta, and Kauffman (2003a) modeled the relationship between product transparency and base consumer demand, and price elasticity of demand. The authors analyze situations where an increase in product transparency increases base demand and decreases price elasticity of demand. The results suggest that firms should price relative to their competitive position in the marketplace and decide upon a level of market transparency so that their transparency strategy maximizes profits. If a firm's aggregate market transparency level is lower than that of a competitor, then the firm should set a lower price to compensate for its lower level of market transparency. Some other normative guidelines from this analysis are summarized in Table 2.

Price Transparency and Willingness-to-Pay

Several studies and analyses in the economics and information systems (IS) literature suggest that price transparency may reduce willingness-to-pay. Brynjolfsson and Smith (2000) report that in business-to-consumer (B2C) markets some retailers charge low prices to attract informed consumers, while others charge high prices that less-well-informed consumers end up having to pay. Wise and Morrison (2000) suggest that even though the Internet has

brought higher liquidity and transparency, sellers have little incentive to participate due to the risk of price pressures. This is especially true, for example, in buyer-focused electronic markets for supply chain management and procurement services, where suppliers suffer from the negative externalities of increasingly intense participation-driven cross-competition (Dai and Kauffman, 2004). More generally, Stigler (1961) showed that a lower price may result if search costs are reduced and a lower market price is discovered.

The economic rationale for this can also be understood in terms of the direct and indirect effects. Regarding the direct effect, in interviews with airline executives, we have received consistent signals that the direct effect of price transparency — lower search costs for cheaper alternatives — is reducing the prices of tickets when consumers purchase online compared to other channels. Regarding the indirect effect, in a transaction-making environment with asymmetric information, buyers are uncertain about sellers' opportunity costs. But now, as Zhu (2004) recognized for B2B e-markets, consumers can better estimate the sellers' opportunity cost with higher price transparency. In addition, the market microstructure literature suggests that dynamic market mechanisms have the capacity to provide higher price transparency. Interpreting what we see more broadly, it appears that more dynamic market mechanisms will tend to lower willingness-to-pay compared to static markets with posted prices. This is in line with eBay's June 2003 report that customers are more informed about prices, which has resulted in a more efficient marketplace but "compressed margins" (Hansell, 2003). Therefore, the direct and indirect effects of price transparency create simultaneous downward pressure on willingness-to-pay.

Supplier Transparency and Willingness-to-Pay

Supplier transparency may have two opposite effects on willingness-to-pay, depending on the information that is made available. First, *identity of the seller* increases the willingness-to-pay, similar to what we concluded about the indirect effect of product transparency, since seller identity includes signals about product quality. For example, in the sale of airline tickets, availability of information about the carrier provides signals about the quality of the product (for example, safety, reliability, and on-board service). These signals of product characteristics allow a consumer to make a better valuation of the product to find one that best matches his or her needs.

Second, *inventory information* and *cost transparency* reduce maximum willingness-to-pay, similar to what we claimed was the indirect effect of price transparency. The reason is that consumers are better able to ascertain the production and opportunity costs of a seller and the consequent reservation price of the seller. This is analogous to knowing the bid-ask spread of a market-making intermediary in the sale of stocks or bonds in the financial services industry. By being able to assess the trading margin of sellers, the willingness-to-pay of consumers will decrease to minimize the sellers' margins.

Market Transparency Indifference Curves

Our analysis so far involves the separate impact of different types of market transparency on consumers' willingness-to-pay. However, firms commonly make joint decisions to disclose product, price, and supplier information. In other words, movements to define the firm's transparency strategy in an industry's market transparency space may involve adjustments in more than one transparency dimension. Based on the likely impacts of market transparency on willingness-to-pay that we have discussed, we will next try to characterize the impact of these joint decisions by introducing the concept of *market transparency indifference curves*. For the sake of expositional clarity, we will focus our analysis on the indifference curves for the product and price transparency, and leave supplier transparency aside for the moment.

The decisions firms face to reveal or conceal information depend on their impact on consumers' economic behavior, assuming that the marginal costs of providing different types of transparency are the same. If we assume that product transparency tends to increase willingness-to-pay and price transparency tends to decrease willingness-to-pay, a seller's indifference curve between product and price information should be an increasing function. In other words, if an increase in price transparency decreases consumers' willingness-to-pay, the seller must increase product transparency to offset the negative effect of price transparency and be indifferent. This provides the beginnings of policy guidance for making transparency strategy decisions.

To deepen the managerial insights that this preliminary analysis yields, it is important to explore the impacts based on the shape of the seller's indifference curves. The curves can be concave, convex, or linear, with each implying somewhat different underlying tradeoff relationships. Assessing the tradeoffs poses difficult managerial questions because it is not easy to compare the

benefits of making product information available vs. making price information available. For example, if an OTA is deciding whether to conceal the airline name from the consumer as part of its transaction-making mechanism, then what pricing information should be made available in order to offset the negative impact of a decision to conceal it? And how will that compare with a decision to conceal the number of stops in the travel itinerary? It should be clear to the reader that this question will require a more complex analysis, and so we leave it for future research. But it is nevertheless important to point out that the design of an appropriate transparency strategy will involve answering questions such as these.

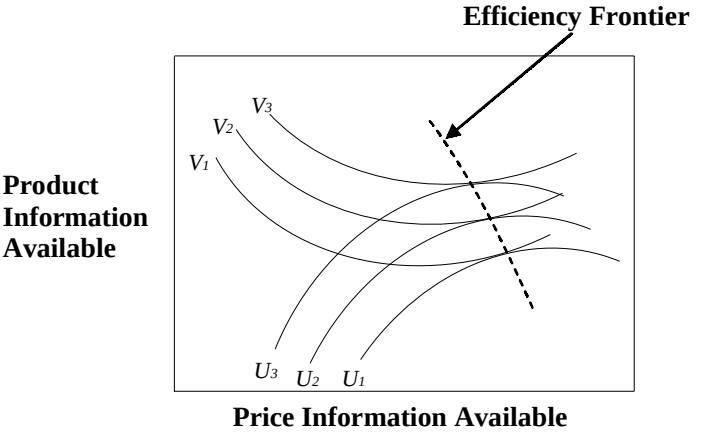
What happens if the marginal return of an increase in product transparency can be more than offset by a similar decrease in price transparency? This is especially the case in financial markets, where pricing information carries valuable signals associated with market efficiency. Investors are likely to be more sensitive to a change in price transparency than they are to changes in product transparency. This financial markets example also suggests that there may be a point in the market transparency space with high-price transparency where less product transparency is necessary. Many traders operate based on observations of price fluctuations with only the basic product information considered (for example, financial ratios, earnings per share, and so forth). There is a diminishing return to the availability of product information such that with very high price transparency, product information becomes almost irrelevant. This suggests that in the market transparency space the form of the indifference curve will be concave. In addition, the curve is likely to be *strictly* concave if information overload about price can occur, such that at some point in the market transparency space, due to price information overload, price transparency has a negative effect on consumers' willingness-to-pay.

Regarding consumers' indifference curves, since consumers value both product and price information, their indifference curves will have a negative slope. In other words a decrease in price transparency must be offset by an increase in product transparency for the consumer to be indifferent. At a point of high price transparency, as observed in financial markets, pricing information suffices and investors are satisfied with a fixed set of product information. Assume this indifference curve is strictly convex. Figure 7 depicts the indifference curves for firms and consumers in the market transparency space. This representation suggests an *efficiency frontier* in the market transparency space, with many possible equilibrium points where both sellers and consumers are able to maximize their payoffs.

Notice that the efficiency frontier occurs at a point of relatively high price transparency. This can partially explain why, in financial markets where dynamic market mechanisms prevail, electronic market structures can be built and will be sustained in their operation for a long period of time as the prevailing trading mechanism in a region or for a specific type of security (for example, the New York Stock Exchange, NASDAQ or the London Stock Exchange). In contrast, in other markets where posted prices prevail, multiple electronic markets with different levels of market transparency are more likely to be found. An example is the airline industry. OTAs have adopted multiple market mechanisms in the market transparency space, attracting consumers with diverse market transparency preferences as shown in Figure 6. But this may also partially explain why, by bringing more dynamic market mechanisms to B2C markets, auction models, such as the one used by eBay, have been successful since the early stages of e-commerce. eBay's high price transparency tends to satisfy both sellers and buyers, such that product characteristics take a second priority. However, Kauffman and Wood (2004) find that the inclusion of a picture with the description of an auction item on eBay tends to increase a buyer's willingness-to-pay.

In summary, we have analyzed the possible consequences of product, price, and supplier transparency on consumers' willingness-to-pay. Generally a

Figure 7. Firm and consumer indifference curves in the market transparency space



Note: V_1, V_2, and V_3 represent the indifference curves of the seller, and U_1, U_2, and U_3 represent the indifference curves of the consumer. The dotted line is the efficiency frontier.

positive impact on willingness-to-pay favors the seller, so a firm should try to induce higher willingness-to-pay with its transparency strategy. We suggest that product transparency reduces search costs for product information, such that there are positive direct and indirect effects of product transparency on willingness-to-pay. In contrast price transparency has negative direct and indirect effects on willingness-to-pay. The results for supplier transparency are mixed, depending on the type of information revealed. We also noted that firms may be indifferent among transparency strategies, and we proposed a means to analyze this via market transparency indifference curves. This offers a first indication regarding the impact of transparency strategy decisions that move a firm along more than one dimension in the market transparency space.

Further Application of the Theory to the Online Travel Industry

In this section, we discuss the future strategies and directions for future research in the OTA industry in the context of the theory of market transparency presented in the previous sections.

Impact of Internet Technology on Market Transparency Potential

The first issue is related to the impact of Internet technology on market transparency. In the OTA industry, consumers have a lot more access to travel-related information than before. If the assumption is that both product and price transparency are valued by the consumer, the OTA industry likely contributes to a higher level of market efficiency where consumers are better able to find the right travel option that satisfies their needs. However, the result for the sellers is less promising in two ways. First, increased levels of market transparency by OTAs put downward pressure on the profits of traditional intermediaries such as travel agencies. The theory of intermediation suggests that the returns to intermediation between suppliers and buyers are higher when search is more costly (Spulber, 1999). Therefore, increased market transparency potential threatens the position of travel agencies in the market structure of air travel distribution.

Second, based on the assumption that an increase in price transparency has a higher negative effect on consumers' willingness-to-pay than a similar increase in product transparency, there is downward pressure on air travel fares as smarter consumers are able to find lower fares and to ascertain the airline's opportunity costs. Our interviews with airline executives point in that direction. Further analysis of the impact of market transparency potential due to the Internet is necessary to support this assessment. For example, models of the OTA industry can be built where the extent of market transparency is a parameter that influences consumer demand.

Market Transparency Space in Internet-Based Selling

In Internet-based selling, OTAs have the flexibility to reveal or conceal information about the product and the supplier in multiple ways, based on the information revealed or concealed and the design of the trading mechanism. Table 3 illustrates market transparency dimensions in the OTA industry based

Table 3: Characteristics of the market transparency space of online travel agents

CONSUMER OBJECTIVE	INFORMATION NEED	INFORMATION
Product quality	Supplier identity	Airline name
	Feature – itinerary	Departure, arrival, layover
	Feature – service	Ground services (for example, e-ticketing, lounge)
	Feature – service	Class of service, meal
Comfort	Flexibility	Adv purchase requirements, refundability, transferability, changes, payment forms
	Warranty	Policy for cancelled flights Customer complaint rules
	Payment form	Online vs. other payment options
Integrity	Safety	Accident record, fleet age
	Reliability	On-time performance, lost luggage, complaints
Price discovery	Posted Prices	Prices of a specific or multiple itineraries
	Demand, supply pressures	Historical demand, prices
	Seller's opportunity costs	Lowest market price, airline inventory

Note: OTAs can select any combination of the above information to reveal to consumer in their transparency strategy

on the information that can be provided to consumers. The table shows the numerous options and combinations that OTAs can select, which shows the explosion of alternatives that firms are faced with when trying to select a transparency strategy.

Transparency Strategy Guidelines for Online Travel Agencies

With the theoretical insights described above, firms can perform a competitive analysis for where they stand relative to the competition in the market transparency space. Given the current options for market transparency in the air travel booking industry, OTAs can assess the soundness of their transparency strategies.

Granados et al. (2003b) analyzed the competitive position of OTAs in the industry's market transparency space. In 2001, Orbitz entered the OTA market with a new technology that is superior to the electronic market technologies that have been provided by CRSs to travel agents and some other OTAs. The CRSs have a number of technological limitations regarding the display of information on travel options that are available to the consumer. Since other OTAs have not been able to develop the software that makes it possible to list tickets as effectively as Orbitz's matrix display, Orbitz has a product transparency advantage based on its technology. Second, Orbitz created contracts with airlines and other OTAs that required the provision and display of the lowest available fares, resulting in a strong price transparency position. Meanwhile, the airline industry's pricing is based on a *price-matching practice* (Morrison & Winston, 1996), which typically causes homogeneous pricing for a given fare type, origin destination, and travel date. The consequence is that consumers tend to prefer Orbitz because its prices are comparable (and sometimes lower) than those posted by other OTAs, based on Orbitz's choice of a very transparent market mechanism. This may explain why Orbitz moved into a position of market leadership so rapidly.

This price-matching environment with multiple selling mechanisms with different market transparency has serious implications for firms with a low market transparency strategy. Generally, to compensate for a lower market transparency, Orbitz's rivals should be offering lower prices, if they wish to appeal to the same segments of the air travel consumer marketplace. However, in

practice, it is difficult to generate price discounts for the consumers that will attract them to less transparent Web sites. The most representative example is Priceline.com. Its mechanism is the least transparent because it only provides product and price information to a bidding consumer once the consumer has made a contract-binding bid. Therefore, it is at risk of losing customers to more transparent OTAs, especially to Hotwire, which targets similarly price-sensitive consumers who are willing to forego product transparency to get a better price. To compensate for the lower level of market transparency, Priceline.com needs to offer incentives to consumers to attract them. The most tangible offer is that of lower prices or special deals. In the price-matching environment that we see among airline firms, this has proven to be difficult for Priceline.com. Legg Mason analyst Thomas Underwood has reported that Priceline.com is bigger and has been more profitable than Hotwire. In addition, the latter is growing more rapidly (Mannes, 2003).[1] This may partially explain why Hotwire was able to pass Priceline.com in the number of new user adoptions just one year after its launch. Meanwhile, Priceline.com has chosen to limit transparency regarding product information, which puts it in a somewhat disadvantageous competitive position going forward.

Another interesting contrast is between Orbitz and Hotwire, the industry consortium OTAs. The airline firms reintermediated the OTA industry with Orbitz and Hotwire. The OTA industry was increasingly characterized by non-airline, third party entrants, including Microsoft's Expedia (www.expedia.com), E-Travel.com (www.e-travel.com), GetThere (www.getthere.com), and Travelocity (www.travelocity.com), among others. They effectively segmented the market with two different market mechanisms, one with a high level of transparency and one with a low level of transparency. Consumers who value information about the airline and their travel itinerary are more likely to be traveling for business or scheduled meetings, so they are likely to purchase on Orbitz. In contrast, price-sensitive leisure travelers are willing to purchase on Hotwire or Priceline.com because they are less concerned about the airline they fly or the specific travel times. So, by leveraging consumers' self-selection, airlines can price discriminate, segment the market, and offer lower prices with less risk of adverse selection or retaliation by competitors.

In summary, OTAs have multiple options to implement transparency strategies. However, due to the technological superiority of Orbitz, other OTAs are now experiencing increased pressure to adjust their transparency strategy choices in the market transparency space to maintain market share. In addition, the option to compensate consumers with lower prices due to lower market

transparency is difficult because of the price-matching environment of the industry. The exclusive contracts that require Orbitz to publish the lowest market prices of other airlines and OTAs increases the pressures felt by competitors. Therefore, we believe that the less transparent OTAs are now faced with rethinking their market transparency strategy.

Conclusions

To conclude, we summarize the contributions of our theoretical exploration of transparency strategy in Internet-based selling, point out some remaining issues, and suggest some directions of future research.

Primary Contributions

We present a new *market transparency theory for Internet-based selling*, with a focus on the consumer's perspective and the implications for firm strategy, and provide insights into consumers' possible responses to changes in market transparency levels and the consequences for organizational strategy. Increasingly, organizations are finding that the information they previously owned or had privileged access to is being shared electronically. Consumers have access to much more information than ever before. We introduce market transparency potential to conceptualize how information technology can increase firms' ability to strategize about the information to reveal or conceal from consumers. The outcomes that we have observed in the OTA industry suggest that the dynamics of the competition are changing dramatically. We call for additional research on the impact of market transparency on firm strategy and industrial organization.

This chapter provides a basis for future research in market transparency in Internet-based selling. We explored the possible consequences of market transparency on consumers' willingness-to-pay, with the recognition that different information may have direct and indirect effects on willingness-to-pay by reducing search costs. Firms with a high level of market transparency may have an advantage in attracting consumers to search on their Web sites, which is indicative of the direct effect. When firms that implement mercantile exchange mechanisms with a high level of product transparency enable consumers to

make more accurate valuations of the product, increasing their willingness-to-pay, we see indications of the indirect effect. Mercantile exchange mechanisms with lower levels of transparency attract consumers who are less concerned about product characteristics and who may be willing to give up product transparency for a lower price. This suggests that pricing and transparency strategy must be closely aligned to ensure that firms are not at a disadvantage relative to competitors with a higher level of market transparency.

Remaining Issues and Next Steps

It is important to recognize that market transparency to the consumer commonly implies market transparency to competitors. If consumers are able to view the information that a firm uses in selling its goods and services, then its competitors normally will be able to view this information and make strategic decisions relative to it. Therefore, in addition to the linked decisions that firms will face in deciding what levels of product, price, and supplier transparency are appropriate, there is also a concern about what will happen when this information is made available to competitors. Although we have not covered the implications of these additional aspects in this chapter, we recognize that further research is necessary to uncover the mixed impact of market transparency to consumers and to competitors.

Our theoretical development of market transparency suggests opportunities for research to confirm some of the exploratory aspects of this analysis. For example, what is the collective impact of product, price, and supplier transparency on willingness-to-pay? While we derived the possible relationship between transparency and willingness-to-pay based on current literature about the impact of search costs on consumer surplus and willingness-to-pay in a trading environment with asymmetric information, there is a need to empirically determine these relationships. Econometric analysis of consumer demand under different market transparency environments can be performed to derive the relationship between market transparency and willingness-to-pay. Also, economic experiments can be performed to compare market mechanisms with different designs and levels of market transparency, to derive the impact of these differences on consumers' economic behavior. Clearly, research in exploring the effect of transparency has implication for managers in a variety of industries, as well as researchers in economics, marketing science, IS, and e-commerce.

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Endnotes

[1] Barry Diller's InterActive Corporation (IAC) acquired Hotwire on September 22, 2003, in a deal that was valued at $685 million. Mannes (2003) reports that, "IAC's deal for Hotwire casts a spotlight on a section of the discount travel market in which consumers buy their plane tickets or pay for their hotel rooms before they learn which airline they'll be flying or exactly which hotel they'll be staying at. Priceline.com calls the system its 'Name Your Own Price' travel service, while IAC calls the market 'opaque' travel." According to comScore/Media Metrix, as reported here, "Hotwire had 7.5 million different U.S. visitors to its site in August … while Priceline.com, which also operates other travel sites and offers personal financial services through a licensee, had 5.6 million visitors to its flagship site." Mannes further cites Legg Mason's estimates that suggest that 2003 profits for Priceline, the market leader, will come out at about $150 million, while Hotwire's 2003 profits will be about $110 million.

Chapter V

Structure Evolution of B2B Enterprise Networks

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Abstract

This chapter analyzes the structural dynamics of multilateral business-to-business (B2B) relationships based on game theoretical approach. It focuses on the evolution of network structures initiated by three major forces: a neutral intermediary, a dominant supply chain partner, and an industry consortium. We show the typical enterprise network structures, identify the conditions that cause structure reconfiguration, and demonstrate the change of social welfare in the evolution process. Web-based technologies have changed the landscape of enterprise networks, and the proposed framework will provide an analytical understanding of the endogenous formation and dynamics of enterprise networks in the information era.

Introduction

Due to the vast benefits of web-enabled networks, they have become increasingly popular in information-intensive industries. Firms realize that business-to-business relationships often have impacts beyond the bilateral exchanges between the firm and its business partner. For example, the well-known bullwhip effect (Lee, Padmanabhan & Whang, 1997) refers to the distortion of demand when the number of intermediaries increases in a supply chain. Thus when the manufacturer evaluates its relationship with a wholesaler, it has to take into account the retailers that the wholesaler serves. Even competing firms are forming horizontal marketplaces, such as the consortia (for example, Covisint, Transora), composed of multiple buyers and sellers to improve purchasing efficiency and facilitate collaboration. Evidently, thanks to information technology, the cost of integrating another firm in the value web continues to decrease. As a result, the formation and evolution of value webs have become highly dynamic.

The benefits of such web-enabled networks are well understood in the industry. They encourage information sharing, thus leading to better coordination among partners in activities such as demand forecasting and new product development. And the formation and evolution of such enterprise networks (EN) have yet to attract attention from researchers. Existing literature in related fields such as economics and management have mostly focused on characteristics of specific network structures that are exogenously given. However little research studies how EN form endogenously and evolve (Tomak & Xia, 2002).

In this chapter we study the formation and evolution of EN. In our setting, each firm is regarded as a rational entity and will create and sever its relationships with others in order to maximize its own payoff. The structure will evolve as firms respond to market changes that will affect their payoff. We analyze three types of EN, which are prevalent in the e-business area. They are: e-Market, EN enabled by a neutral intermediary; e-Hub, EN enabled by information sharing across a dominant supply chain partner; and industry consortia, EN enabled by a buyer-based consortium.

The remainder of the chapter is organized as follows. The next section gives an overview of EN and reviews related literature on network economics; the section on model settings presents the general model of EN; the next sections separately discuss the evolution of the three types of EN; and the final section concludes with a summary of our findings and some future research directions.

Economics of Enterprise Network

Definition: An Enterprise Network (EN) is a network formed among multiple enterprises to realize certain functions.

EN facilitates business transactions among trading partners. The relationships among them can be general and broad, from arm-length relationships to strategic alliances to even market-based relationships. Supply chain networks and spot markets for particular products are examples of EN. To fulfill critical business imperatives, self-interested firms are always seeking efficient connections with their trading partners. While some general trends are well known[1], it is not clear which network structures are more likely to form and which ones are more stable. More importantly, knowing the conditions of obtaining stable networks before and after the changes, we can gain insights into the critical factors leading to new stable networks, properties of new EN, and the resultant change in social welfare.

To answer these questions, we use non-cooperative network games to simulate the network formation and evolution process. Economists have used the game theoretical approach to model network formation for some time (Aumann & Myerson, 1988; Myerson, 1991). Their findings can be grouped into three categories: (1) The importance of network relationships in determining the outcome of economic interactions (Jackson, 2003); (2) Some dominant and stable network structures under various circumstances (Bala & Goyal, 2000); (3) Relationship between stability and efficiency of networks (Jackson, 2001). Our work extends the concepts in network economics to make it closer to real-world scenarios of IT-enabled EN. We incorporate heterogeneous players such as buyers, sellers, intermediary, and industry consortia. And value functions of players in our study are more concrete. We identify three dominant ways to restructure business connections in the Internet era: connections through a neutral intermediary to identify and reach new partners (for example, FreeMarkets and Converge); connections through a dominant supply chain partner to share information collectively (for example, Cisco and Wal-Mart); and connections through a consortium to emphasize industry-level connectivity (for example, Covisint and Transora).

Type I EN is an exchange market between buyers and sellers. With the aggregation benefits of B2B electronic marketplaces (Yoo, Choudhary & Mukhopadhyay, 2003), the intermediary enters the originally direct buyer-

seller network and causes a shift to the intermediary-centered network. Type II EN is a linear supply chain where the traditional information flow is a chain structure along with the material flow. To increase the network level visibility, a dominant supply chain partner invests in e-Hub, which is a star structure with centralized information exchange platform. Type III EN also focuses on the exchange market between buyers and sellers. To reduce redundant connections and increase bargaining power, buyers form a consortium. Collaborative sourcing transfers the direct buyer-seller network to a fan structure. Propositions in this chapter show the equilibrium conditions for each dominant structure, which enable us to compare social payoffs before and after the evolution and discover important properties of the evolution process.

General Economic Model Settings

We use graph G to represent the EN structure. In G, $g_{ij} = 1$ means there is a link between agent i and agent j, otherwise $g_{ij} = 0$. Value function $V_i(G)$ denotes the expected payoff of agent i in the network G. Agents in EN exchange physical products or information goods. Individual payoff is achieved from realized trades among agents, and it will be determined by network structure and the agent's relative position in the entire network. Agents incur certain costs, such as startup costs, link costs, and switch costs, to build and maintain links.

We focus on two properties of EN: equilibrium and efficiency. Efficiency emphasizes the social welfare, which is the total payoff of all participants in the network. Equilibrium means that no agent wants to deviate from the current status when other agents keep their existing links. We utilize the concept of pairwise stability proposed by Jackson and Wolinsky (1996), which requires the consent of both parties when inter-firm relationships are to be established, while severance of a connection can be done unilaterally. Arcs in the equilibrium network G should satisfy the following conditions:

(i) for all $ij \in G, V_i(G) \geq V_i(G - ij)$ and $V_j(G) \geq V_j(G - ij)$

(ii) for all $ij \notin G$, if $V_i(G) < V_i(G + ij)$ then $V_j(G) > V_j(G + ij)$, and vice versa

Type I EN (e-Market): EN Enabled by a Neutral Intermediary

Direct Buyer-Seller EN

Without any intermediary, buyers and sellers form direct links to exchange goods. Buyer set *(B)* has *m* buyers and seller set *(S)* has *n* sellers. During a time period, each buyer demands one unit of a good and each seller produces one unit of a good. In many cases, competition is on the seller's side, so we assume $n>m$. It is easy to extend our analysis to the buyer-side competition and derive a similar outcome. For one unit of good, each buyer has the same willingness to pay, 1. Each seller S_i has production cost c_i, which is independently and identically distributed on [0,1] with uniform distribution F. F is common knowledge while c_i is only known to the seller S_i.

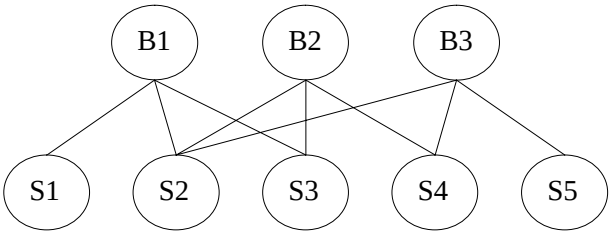
In the market, we limit the bilateral exchanges only between the linked buyers and the sellers. Kranton and Minehart (2001) give a detailed discussion about the reason to introduce such a bilateral relationship to facilitate a particular exchange. We assume that it costs a buyer c_b and a seller c_s to build and maintain such a link in one period. A second price auction is adopted to generalize the competition for goods. Overall linkage pattern and the auction mechanism will jointly determine the final allocation of goods.

The network formation process can be described as the following two-staged game:

- **Stage One:** Buyers and sellers simultaneously determine whether to maintain a link between each other. The network *G* is observable to all players.
- **Stage Two:** Each seller privately knows its reservation value, and they compete in the second price auction constrained by the linkage pattern.

Definition: The Least-Link Allocatively Complete (LAC) EN is a network guaranteeing the efficient goods allocation[2] between two groups of enterprises with overall fewest links.

Figure 1. LAC EN with three buyers and five sellers



The LAC EN (Figure 1) is the only efficient structure in direct buyer-seller networks (Kranton & Minehart, 2001). With any realization of the sellers' production costs, the LAC structure can always deliver goods from sellers with lowest production costs to all buyers. In a LAC EN, each buyer has *n-m+1* links. But the sellers' positions are asymmetric, and the number of their links ranges from *1* to *m*.

With the range of small-link costs shown in Proposition 1, LAC networks are the only equilibrium outcome of the game.

Proposition 1 Equilibrium of the LAC EN: For

$$0 \le c_b \le 1/\binom{n}{m}(n+1)$$

and

$$0 \le c_s \le 1/\binom{n}{m}(n+1),$$

the LAC EN is the equilibrium as well as the only efficient EN.

The expected social welfare is:

$$m\{\frac{2n-m+1}{2(n+1)}-(n-m+1)(c_b+c_s)\}.$$

In the following section we will show that the entrance of the intermediary improves the social welfare.

Buyer-Seller EN with a Neutral Intermediary

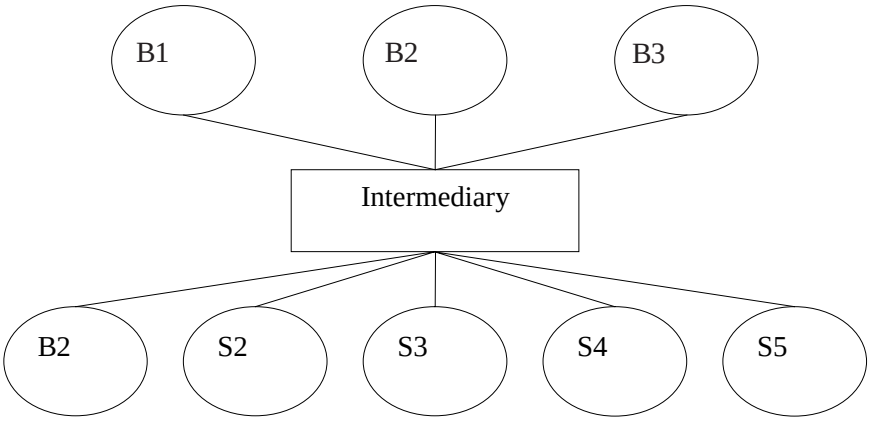
In direct buyer-seller networks, both sets have to maintain multiple links to keep relatively strong bargaining power and get the highest expected payoff. With the entry of a neutral intermediary, a large number of buyers and sellers can be gathered together while each of them only needs a single linkage to the intermediary. Buyers and sellers will incur switching costs to change from traditional buyer-seller connections to intermediary-based connections. In the model, we assume that the switching costs are the same for the buyers and sellers. De facto the degree of IT adoption and transaction standardization can affect the levels of switching costs (Yoo et al., 2003).

The following game simulates the evolution process initiated by the entry of the intermediary.

- **Stage One:** An intermediary, who has spent investment I, invites buyers and sellers to participate with entrance fee e_b and e_s, respectively[3]. Buyers and sellers simultaneously decide whether to join with switching cost s_b and s_s. Network G is observable to all participants.
- **Stage Two:** Each seller privately knows its reservation value, and sellers compete in the second price auction constrained by the connection patterns.

Definition: The Intermediary-Centered (IC) EN is a network where two groups of enterprises connect to each other through an intermediary.

Figure 2: IC EN with three buyers and five sellers



Limited by computational complexity, Proposition 2 only considers the investment level under which LAC networks will transform to IC networks (Figure 2), where all buyers and sellers only have one link with the intermediary. In the real world, there are variations where both direct buyer-seller links and intermediary-centered links can coexist.

Proposition 2 (Equilibrium of the IC EN): For

$$I < m\{(n-m+1)c_b - s_b\} + n(c_s - s_s)$$

the LAC EN will change to the IC network, which is the only equilibrium and efficient EN.

Based on Proposition 1 and 2, we find two critical factors that make the evolution process initiated by the neutral intermediary more likely to happen:

- **Property I.1:** The more buyers and sellers are in the direct buyer-seller networks, the easier the intermediary achieves aggregation benefits profitably.

- **Property I.2:** The lower the switching costs incurred by buyers and sellers, the easier the IC EN substitute the LAC EN.

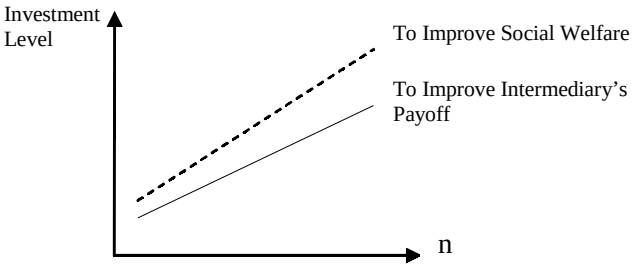
In the new structure, the expected social welfare is:

$$m\frac{2n-m+1}{2(n+1)} - ms_b - ns_e - I \,.$$

The entry of the intermediary not only causes the structure evolution but also increases the social welfare. However, the intermediary tends to under-invest because sellers have asymmetric positions in direct buyer-seller networks, and some of them share increased social welfare from the intermediary's investment under the uniform entrance fee. The more the number of sellers in the direct buyer-seller networks, the larger the incentive gap becomes.

- **Property I.3:** The investment level under which the intermediary is willing to invest is lower than the investment level under which the social welfare can be improved (Figure 3).

Figure 3. Gap between the intermediary optimal investment level and the social optimal investment level



Type II (e-Hub): EN Enabled by Information Sharing Across a Dominant Supply Chain Partner

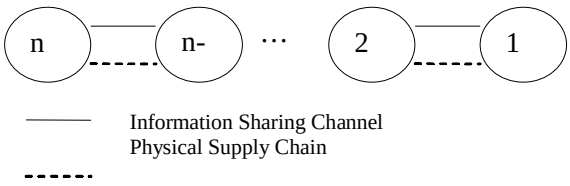
Linear Information Sharing Model

We study information sharing problems among *n* supply chain partners. They form a linear physical supply chain where the information flow is independent from material flow. We assume each partner owns one unit of information that has a value of 1. We generalize all kinds of valuable information, and the importance of information owned by different partners is treated equally. The parameter $\delta \in [0,1]$ measures the efficiency of information transmission. And when the information-sharing channel coincides with the physical supply chain, we normalize the information link cost to zero. Otherwise partner i will incur a cost c_{ij} to maintain an additional information link with partner j. The value function for each partner in the information-sharing network *G* is:

$$V_i(G) = 1 + \sum_{j:\, j \neq i} \delta^{t_{ij}} - \sum_{j:ij \in G} c_{ij},$$

where t_{ij} is the shortest path between partner i and partner j. For a group of supply chain partners, the chain network represents the traditional linear information-sharing channel that is consistent with the material flow (Figure 4).

Figure 4. Linear information sharing model



Definition: The chain EN is a network where a group of enterprises connect with each other sequentially and the two end nodes are disconnected.

The information network G will have different stable structures based on the range of the information link cost (Jackson & Wolinsky, 1996). When $c > \delta - \delta^{n-1}$, no additional information link can be profitable and the chain network is the unique equilibrium structure.

Collaborative Information Sharing

E-Hub is an innovative information-processing model (Lee & Whang, 1998), in which all supply chain partners collaborate and share information through a central point. By adding only one link to the hub, each partner can receive the information from all other partners without any intermediary agents. A supply chain partner will be the initiator in the e-Hub model, and other partners incur a link cost to connect to the e-Hub.

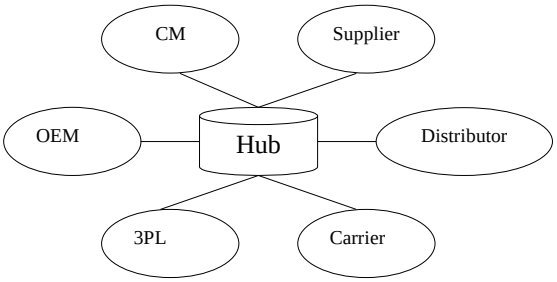
Definition: The Star EN is a network in which an enterprise becomes a central point and all the other enterprises coming from the same group only connect with it.

With a small information link cost c and low e-hub infrastructure investment I shown in Proposition 3, collaborative information sharing in an e-Hub will become a star network (Figure 5). The supply chain partner initiating the e-Hub, such as Cisco, is the central point in the star network.

Proposition 3 (Equilibrium of the Star EN): For $c < (n-3)(\delta - \delta^2)$ and $I < 1 + (n-1)\delta - (1-\delta^n)/(1-\delta)$, the star EN will be the unique stable and efficient structure of the information sharing network originated from the chain EN.

Proposition 3 implies the following characteristics of the formation of the star network when a group of supply chain partners adopt the e-Hub model.

Figure 5. Collaborative information sharing in an e-Hub



- **Property II.1:** The more supply chain partners (n), the more likely the emergence of a star EN.

It is quite intuitive; the benefits from collaborative information sharing will increase with the number of participants because of the positive network effects. Cisco plans to embrace more than 2,000 of its supply chain partners into its e-Hub (Grosvenor & Austin, 2001). Wal-Mart has linked many of its 25,000 suppliers to a trading network it set up in 1991 (Young, 2002).

- **Property II.2:** The end players in the supply chain have more incentive to initiate the e-Hub.

The reason is that end players face severe information loss in the linear transmission channel. For example, Mathias and Kapur (2002) mention a case where a leading upstream supplier runs an e-Hub to work with its manufacturers.

Social welfare will increase in the evolution process because the number of participants does not change in the evolution and individual firms have incentive to join the e-Hub only when they can receive better payoff.

Type III (Industry Consortium): EN Enabled by Buyer-Based Consortium

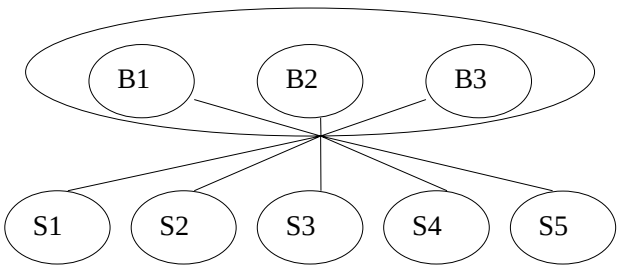
Buyer-Based Consortium in a Market with Seller-Side Competition

The model is analogous to the one in the section dealing with Type I. Instead of the entry of a third party, buyers coordinate with each other actively. And in the full participation scenario, they will form a consortium as a virtual monopoly in the market. In order to achieve collaborative sourcing at the consortium, they need to coordinate with each other. Each buyer in the consortium will face a coordination cost, which is a linear function of the number of participants in the consortium: k* the number of participating buyers. Buyers and sellers incur switching costs when they use consortium-based connections instead of buyer-seller direct links.

Definition: The Fan EN is a network in which a consortium of enterprises becomes a central point and all the other enterprises coming from a different group only connect with it.

When all buyers join the consortium and sellers only have one link to it, the buyer-seller network becomes a fan network (Figure 6) and the buyer-based consortium becomes the central point. For small coordination costs among buyers and small costs incurred by sellers to connect with the consortium, the fan network is the equilibrium outcome of the game.

Figure 6. Fan network incorporating the buyer-based consortium



Proposition 4 (Equilibrium of the Fan EN in the Buyers' Market): In the case where competition is on sellers' side, when

$$k < \frac{n-m+1}{m} c_b - \frac{s_b}{m}$$

and

$$s_s + c_s \leq \frac{m(m+1)}{2n(n+1)},$$

the LAC EN will change to the fan EN.

Our finding shows that buyers are more likely to form the fan network if the number of sellers joining (n) is high. But a large number of buyers in the consortium will have negative reactions to the formation of the consortium because it will be more difficult to coordinate among the buyer group. Sellers can also enjoy benefits from reduced connections and aggregated demand while not weakening their bargaining power. When competition is on the sellers' side, buyers are willing to form a consortium to gain benefits from reduction of link costs, if the coordination costs over the network are low. Benefit from improved bargaining power is not significant, as price is already competitive.

Buyer-Based Consortium in a Market with Buyer-Side Competition

If in direct buyer-seller networks there are more buyers than sellers, then the buyer-based consortium will change not only the linkage pattern but also the trading mechanism in the network. When small and medium-size buyers constitute the consortium, the aggregated demand will increase their bargaining power. In the extreme full participation case, buyers can even squeeze all sellers' profits.

When $m > n$, we assume that each seller produces one unit of good at cost zero. Each buyer has a different willingness to pay that is independently and identically drawn from a uniform distribution F between 0 and 1. The outcome from the direct buyer-seller network setting is a natural extension of the case we discussed before. The LAC network is the equilibrium and only efficient structure with low link cost. In any LAC network, each seller keeps $m - n + 1$ while buyers' positions are asymmetric.

When buyers form the consortium, they incur the same coordination cost function as before. The difference is that if all buyers agree to join the consortium, they can form a virtual monopoly in the market and determine the price that makes the surplus of sellers close to zero. Aggregated demand increases buyers' bargaining power significantly in this case. Buyers adopt egalitarian allocation rule, where goods are delivered to buyers with the highest willingness to pay while the surplus is split equally among all buyers. Egalitarian allocation rule has very nice properties in terms of aligning individual incentives with efficiency (Jackson, 2001). To let the fan structure be the equilibrium outcome of the game, coordination costs among buyers should be within the range given in the following proposition. Still, the greater the number of buyers in the network, the less likely fan network will emerge.

Proposition 5 (Equilibrium of the fan EN in the Sellers' Market): In the case where competition is on buyers' side, when

$$k < \frac{1}{m}\{\frac{n(m-n)}{m(m+1)} + c_b - \frac{n(s_s + c_s)}{m} - s_b\},$$

the LAC EN will change to the fan EN, where each seller's expected payoff is close to zero.

Proposition 4 and 5 jointly imply two important properties of the buyer-based consortium:

- **Property III.1:** The formation of the buyer-based consortium will cause the fan EN to substitute the LAC EN in the buyer-seller exchange market.

However the market competition has significant impacts on the equilibrium conditions under which the evolution can be predicted.

If competition is on the sellers' side, the trading mechanism does not change since buyers have already enjoyed advantages from competitive price before. If competition is on buyers' side, bargaining power in the market will change dramatically. In that situation, improved bargaining power is another major benefit that buyers gain from the consortium. Meanwhile the formation of the consortium is more difficult. Sellers are reluctant to join, since their bargaining power is weakened by the formation of the consortium. Moreover buyers' heterogeneous positions in the direct buyer-seller network make it difficult to allocate the benefits coming from the consortium (Kaplan & Sawhney, 2000).

- **Property III.2:** In the evolution caused by the buyer-based consortium, the improvement of the social welfare is uncertain because of the emergence of the monopoly power that is counterbalanced by the reduced overall connection costs.

In the EN, if all entities are free to choose between their current links and new options, network evolutions usually increase the social welfare. However, in the evolution caused by the buyer-based consortium, sellers are forced to connect to the consortium even if their payoffs are worse than in LAC networks. So the improvement of the social welfare is uncertain.

Conclusions

In this chapter we show how self-interested firms can form different forms of collaborative EN to maximize their individual payoff. Our work provides managerial implications to better manage the dynamics of EN and understand strategies to develop B2B relationships.

Reduced link costs and improved efficiency of products allocation are main reasons to introduce an intermediary. With enough participants in the original network, and with ease of connecting to the intermediary using IT, a fundamental structural shift from direct buyer-seller networks to an intermediary-

centered network will be expected. Collaborative information sharing at the e-Hub fundamentally changes the individual information exchange mechanism. An independent and centralized information sharing process provides better visibility, and better information quality from collaboration is beneficial for all partners. Feasibility of e-Hub evolution depends on both the number of participants and the efficiency of information transmission. Aggregation of buying power provides economies of scale, and reduction of link costs is one major benefit buyers can enjoy from the formation of the consortium. Low coordination costs among buyers are critical to realize this type of evolution.

Web-based technology is the key driver to realize the collaboration among many trading partners. Advanced IT provides strong aggregation capabilities to the intermediaries with low set-up costs. The Internet makes it much easier for many parties to connect with the intermediary than before. IT enables real-time information exchanges at e-Hub. Web-based technologies provide an efficient form of information transmission across multiple organizations, and they enable connection of heterogeneous participants.

Future extensions can be made based on our work. In this chapter we only consider the full participation situations. Future research can be extended to more interesting partial participation cases. For example, if only some buyers join the consortium, how will the buyers' and sellers' bargaining power change due to emergence of the consortium? We assume homogeneous information value in the model. In many cases information value owned by different partners is heterogeneous. For example, Wal-Mart is interested in inviting only direct suppliers to join its e-Hub while Cisco encourages both direct and indirect partners to join the e-Hub. Future extensions on the model will address these issues.

We study the Web-enabled inter-organizational systems from the network perspective. More subtle issues can be identified at the organizational or inter-organizational level. How does the firm improve its internal operations to achieve better external collaborations? In collaborative information sharing, firms need to decide the level of information they want to publish at the e-Hub. The firm that initiates the e-Hub, for example, Cisco, may increase its bargaining power in the supply chain because even upstream suppliers have to go through the e-Hub to share information with their buyers, which they did not have to do before participating in e-Hub. Trust and past collaboration experience will influence the coordination effort in the buyer-based consortium. Evolution of EN thus provides us a rich research area in the information systems field.

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Endnotes

1 Some firms, such as Adaptec, spread out their supply chain globally (Lee & Whang, 2001). Others, such as Li & Fung and Nike, use loosely coupled networks to substitute tightly coupled integration (Brown, DurchSlag & Sagel, 2002). Still others adopt industry-wide e-business standards, such as those created by RosettaNet, to facilitate inter-organizational transactions.

2 Efficient goods allocation ensures that transactions only happen among enterprises with lowest costs or highest valuations.

3 For unit demand in the model, the entrance fee can be considered transaction-based.

Chapter VI

Perceived Risk and Escrow Adoption in Online Consumer-to-Consumer Auction Markets: An Economic Analysis

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Abstract

Escrow is an emerging trust service in online consumer-to-consumer auction markets in preventing Internet fraud. This chapter studies the effect of traders' perceived risk on the adoption of online escrow service (OES). This research establishes decision-making models for both the

honest trader and the monopolist OES provider. Perceived risk rate (PRR), a dynamic measure of perceived risk for online traders, is introduced to link the two decision-making models together. A calculative model for PRR is proposed, and the primary outcomes from the computer simulation for PRR measurement are presented. This chapter reveals that OES adoption is positively correlated to the estimated level of traders' PRR. A higher PRR definitely leads to a higher OES adoption rate and hence reduces the Internet fraud in the auction markets. In addition, an overestimate of PRR leads to higher adoption rate, lower defrauding rate, and higher fraud blocking rate.

Introduction

In the past several years, commercial activity on the World Wide Web has brought about leaps in electronic commerce. In particular, customer-to-customer (C2C) online auctions have turned virtually every Internet user into a potential trader. The growing revenues received by C2C businesses, such as eBay, show a promising future for e-commerce. However, the increasing amount of Internet fraud makes potential traders reluctant to trade online. According to the Internet Fraud Watch, operated by the National Consumers League, fraudulent online auction sales have remained the number one source of Internet fraud in the past several years. During 2002, 90% of the fraud cases reported to the Internet Fraud Watch were online auction related, rising from 70% in 2001. Also the average loss per claim for online auction fraud rose from $326 in 2000 to $411 in 2001 (Internet Fraud Watch, 2002). These statistics reveal the risks of losses due to fraud that current online traders face, as well as the potential loss of trust in online markets among traders due to fraud.

Recently, online escrow is emerging as an important type of trusted third party (TTP) in Internet-based auction marketplaces.[1] Online escrow service (OES) providers, such as Escrow (www.escrow.com), have become major players in preventing Internet fraud. OES providers act as a TTP in an online auction, providing secure methods for transferring items and payments to both parties. Therefore, OES has received much interest from most C2C auction businesses.

Internet-based auction marketplaces are characterized by asymmetric information (Choi, Stahl & Whinston, 1997), meaning that the transacting parties do

not have the same information (Akerlof, 1970). Among the many aspects of asymmetric information, two are closely related to online fraud: one is the uncertainty of the identity of the online trader; the other is the uncertainty of the merchandise quality.

Online traders can easily remain anonymous or change identities. In online C2C auction markets where numerous individuals participate, it is nearly impossible to attribute an identity to any particular trader. Since honest traders are unable to observe the honesty of their trading partners, perceived risk (Beach, 1997; Clemen, 1996; Cunningham, 1967; Grewal, Gotlieb & Marmorstein, 1994) plays a critical role in trading decisions. In a recent study on economic modeling of OES (Hu, Lin, Whinston & Zhang, 2001), perceived risk plays an important role in decision-making of OES adoption. Complementary to perceived risk, trust has been extensively studied in the application of electronic commerce. For example, Kollock (1999) explores endogenous solutions (for example, the feedback system in eBay) to the problems of risky trade in electronic markets. Lee and Yoo (1999) focus on the problem of quality discovery in the electronic trade of physical goods. Ba, Whinston, and Zhang (2003) design a TTP that can facilitate trust-building in the online environment by binding trading agents' reputations with their online identities.

Recently, the relationship between perceived risk and trust has become an important research topic. It has been argued that securing online transactions with trust services provided by TTP can eliminate the effects of perceived risk, and therefore increase the social welfare in Internet-based electronic markets (Chircu, Davis & Kauffman, 2000; Friedman & Resnick, 2001; Resnick, Zeckhauser, Friedman & Kuwabara, 2000).

This chapter is intended to study the effect of perceived risk on OES adoption in Internet-based C2C auction markets using both theoretical and experimental approaches. The next section defines perceived risk rate, a measure of an honest trader's risk perception in C2C auction markets that involve traders, cheaters and online escrow service providers. In the section after an honest trader's decision-making problem is discussed and online escrow adoption criteria are derived. This leads to a discussion of the monopolist OES provider profit maximization problem in the optimum pricing section, which then leads to a discussion of the issue of perceived risk rate estimation. The measurement section briefly introduces a PRR measurement model and presents primary outcomes from the simulation of PRR.

Agents in Online Auction Marketplaces with Online Escrow Services

There are three types of agents in an Internet-based auction marketplace with online escrow services: two types of traders, honest types and cheating types, and OES providers. An OES provider's goal is to maximize the expected profit from its OES by designing the best OES fee scheme that can leverage the usage of its OES. An honest trader maximizes his or her expected utility by deciding whether or not to adopt an OES to prevent possible Internet fraud. A cheater maximizes his expected utility by determining whether to cheat under different circumstances. Cheaters know that an OES can protect honest traders from Internet fraud.

An online escrow service provider operates by holding a buyer's payment in escrow. A seller ships merchandise to a buyer only after the buyer has paid the OES provider, implying that a fraudulent payment can be detected. Payment is released to the seller after the buyer has inspected and accepted the seller's merchandise. If the buyer is unsatisfied with the merchandise, the buyer can return the merchandise to the seller. The buyer's payment is then refunded by the OES provider. Escrow service fees are usually based on transaction amounts and the methods of payment used by the traders.

We assume that online escrow can effectively protect trades from fraud and facilitate transactions. This implies that once the escrow service is used, the adoption party will be protected from the Internet fraud, and the loss is minimized.

An honest trader's decision to adopt an OES is dominantly affected by his or her risk perception in a trade, since his or her objective is to maximize the

Table 1. How online escrow service benefits traders

When the trader is a buyer	When the trader is a seller
1) Enables the buyer to inspect the merchandise before the seller is paid; 2) Gives the buyer the flexibility of multiple payment options and the safety of a trusted third party holding the payment.	1) Provides protection against fraudulent credit card, insufficient funds and credit card charge-backs; 2) Allows the seller to accept multiple forms of payment without the added expense of maintaining a merchant account; 3) Attracts buyers who otherwise may be wary of conducting business with strangers.

expected utility. We define the risk level that a trader estimates the likelihood of fraud, before the type of trading partner is identified, as perceived risk rate (PRR). PRR is a subjective measure from a trader's perspective for the likelihood his or her trading partner may cheat. It depends on several factors: the Internet fraud rate, a trader's experience with Internet losses, either direct or indirect, the trader's instinctive feelings about the trading partner's honesty, and the amount of the final trade transaction. The Internet fraud rate is an objective factor and is uniformly known among all traders. All other factors are trader- or trade-specific and subjective to the traders' and the trade's specific characteristics. So PRR varies from case to case, trader by trader, and is significantly affected by the information a trader possesses. It directly affects a trader's decision-making in buying or selling as well as in adopting online escrow.

Although PRR is deterministic to a trader involved in a given trade, it is a random variable to an OES provider because the heterogeneity of traders imposes stochastic properties to PRR levels. Denote the trade set as I. Let ξ_i be the random variable for an arbitrary trader's PRR in trade $i \in I$ before the decision of OES adoption is made. The PRR distribution function in trade i from an OES provider's viewpoint can be defined as:

$$F_i(x) = Prob\{\xi_i \geq x\} = \int_x^1 f_i(s)ds \qquad (1)$$

where $f_i(\cdot)$ is PRR's density function in trade i.

$F_i(x)$ is the probability that a trader's PRR regarding trade i is greater than x.

Honest Trader's Decision-Making Model

The following are notations to be used in the decision-making model for an honest trader:

- p_i – trader's PRR when no online escrow is used
- q_i –the likelihood that an honest trader believes that a cheater still cheats when he or she adopts online escrow

- M_i – the transaction amount in trade *i*
- V_i^b – buyer's net utility value of the merchandise to be purchased in trade *i* excluding other costs, such as shipping
- V_i^s – seller's reservation value of the merchandise being sold in trade *i* excluding the shipping fee and other costs
- U_{i0} – trader's expected utility from trade *i* without paying for online escrow
- U_{i1} – trader's expected utility from trade *i* when paying for online escrow
- r – the rate of escrow service fee, based on the percentage of the transaction amount.

Assumptions:

1. An honest trader's utility is defined as an expected net monetary value from the trade weighted by estimated PRR.
2. The honest trader is aware that his or her trading partner could be an honest trader as well as a cheater. The trader can opt for using or not using online escrow to optimize the expected utility from the trade.
3. If an OES is to be adopted in a trade, it must be under consensus of both traders involved in the trade. Accordingly, the payment sent to an OES provider covers the costs for both the merchandise and the escrow services.
4. If Internet fraud occurs, the loss is assumed to be completely irrecoverable in the transaction amount for an honest buyer or in the reservation value of an honest seller at the time being, regardless of whether the cheater is discovered or not or whether the loss will be recovered later.
5. No substitution effect is considered regarding other risk-reduction choices, such as insurance.

If the trading partner initiates the OES, the trade is secured without the honest trader's cost in the OES. In the alternative case that the trading partner does not initiate online escrow, the honest trader must decide whether he or she will use online escrow to protect his or her benefits from fraud. The honest trader also has to take into account the extra escrow service fee charged by the OES provider. This is an opportunity cost: If the trading partner is also honest, using

online escrow is unnecessary. However if the trader does not adopt online escrow, he or she will suffer a total loss if the trading partner is a cheater.

The trader's decision tree is shown in Figure 1 with the payoffs listed in Table 2. Although each trade may incur a certain amount of overhead cost, such as the trader's effort, we assume it is negligible to simplify the comparison between different payoffs. There are three decision-making points for the honest trader, the trading partner, and nature that control the nodes under the "uncertain point" (Kreps, 1990). At the "uncertain point," the honest trader may confront a cheater with subjective probability p_i, which is his or her estimate of PRR. The dotted line connects two rectangular nodes for the trading partner if he or she is a cheater. It is obvious if the honest trader does not adopt the OES, a cheater will definitely cheat. If the honest trader adopts the OES, a cheater may continue to cheat with probability q_i if doing so will benefit him or her more than trading honestly.

Without losing the validity, the case that two traders jointly pay the OES fee can be skipped.[2] Therefore, the online escrow adoption decisions by the honest trader result in the following outcomes in three cases:

Figure 1. An honest trader's decision tree for OES adoption

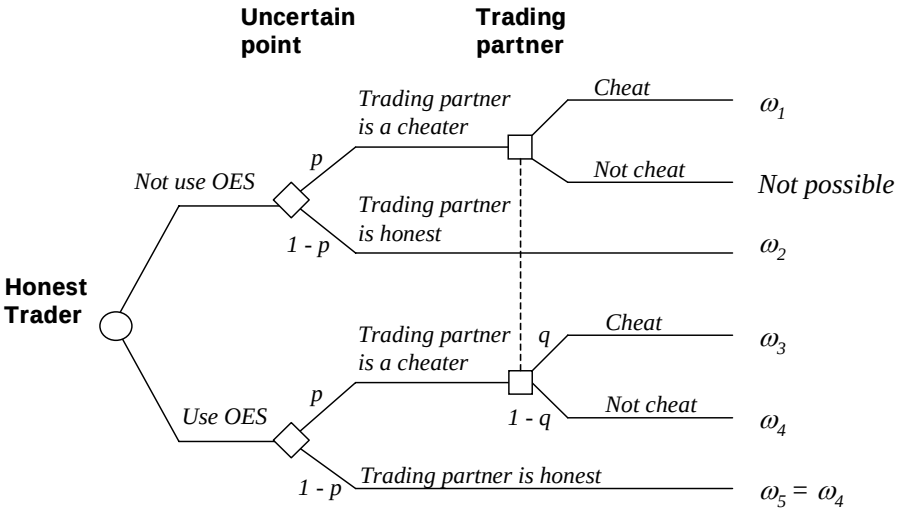


Table 2. The honest trader's payoffs under different conditions

Payoffs	When the trader is a buyer	When the trader is a seller	Notes
ω_1	$- M_i$	$- V_i^s$	When online escrow is not used, the trader is cheated.
ω_2	$V_i^b - M_i$	$M_i - V^s_i$	No OES fee is paid.
ω_3	$- rM_i$	$- rM_i$	The trader pays OES fee and the trading partner cheats.
ω_4	$V_i^b - M_i - rM_i$	$M_i - V_i^s - rM_i$	The trader pays OES fee and the trading partner does not cheat.

Case 1: No trader in the trade is to adopt online escrow.

The trader's expected utilities when he or she is in different trading roles are negatively affected by possible cheating by his or her trade partner:

$$\text{For a buyer: } U_{i0} = (1 - p_i)(V_i^b - M_i) - p_i M_i \quad (2a)$$

$$\text{For a seller: } U_{i0} = (1 - p_i)(M_i - V_i^s) - p_i V_i^s \quad (2b)$$

Case 2: The trading partner pays for the OES.

It signals the honest trader that his or her trading partner is honest. Therefore, his or her *PRR* equals 0. The honest trader's expected utilities are:

$$\text{As a buyer: } U_{i0} = V_i^b - M_i \quad (3a)$$

$$\text{As a seller: } U_{i0} = M_i - V_i^s \quad (3b)$$

Case 3: The honest trader pays for the OES.

In paying the OES fee, the honest trader incurs an extra cost, but in so doing reduces his or her risk from fraud. The honest trader's PRR may change after he or she decides to pay for online escrow. The utilities when the honest trader is in different trading roles are:

$$\text{As a buyer: } U_{i1} = (1 - p_i q_i)(V_i^b - M_i - r M_i) - p_i q_i r M_i \quad (4a)$$

$$\text{As a seller: } U_{i1} = (1 - p_i q_i)(M_i - V_i^s - r M_i) - p_i q_i r M_i \quad (4b)$$

If the trading partner does not pay for the online escrow, when $U_{i1} \geq U_{i0}$ and $U_{i1} \geq 0$, the trader will use online escrow because of higher expected utility. Solving (2) and (4), we obtain the criterion that the trader will pay for the OES:

$$p_i V_i^b / M_i - p_i q_i V_i^b / M_i + p_i q_i \geq r, \text{ if he or she is a buyer} \quad (5a)$$

$$p_i - p_i q_i + p_i q_i V_i^s / M_i \geq r, \text{ if he or she is a seller} \quad (5b)$$

Assume the honest trader believes the OES will totally block the possibility of Internet fraud. That is, $q_i = 0$. Thus we have a pair of simplified OES adoption criteria:

$$p_i \geq r M_i / V_i^b, \text{ if he or she is a buyer} \quad (6a)$$

$$p_i \geq r, \text{ if he or she is a seller} \quad (6b)$$

Equation (6a) and (6b) reveal the important linear relationship between the adoption of OES and OES price with regard to PRR. In particular, an honest seller will compare his or her PRR directly with the OES fee rate to determine whether OES is worth using.

Alternatively, we can also assume $q_i = 1$; that is, the trader believes online escrow will not change the cheater's mind about cheating. Although (6a) and (6b) will change the form, the above conclusion remains the same.

Monopolist OES Provider's Optimum Pricing Problem

An OES provider is assumed to be a monopolist with regard to an Internet-based auction site. This assumption is based on two facts. First, auction sites normally ally themselves with one designated OES provider for their traders.[3] Under this setting, the OES provider can dominate the online escrow business in a cyber marketplace without considering other competitors. Second, a few

OES providers have already acquired majority market shares. For example, Escrow.com is a dominant player in online escrow markets.

An OES provider maximizes its total profits by designing a proper service fee scheme poised between greater overall usage volume for services and a higher return from each usage occurrence. The demand for the OES is defined as the number of trades that adopt online escrow, which is just the *OES adoption rate* times the total number of online trades. It can be derived from the PRR distribution following the preceding analyses in the decision-making models. With the combinations of a trader's role in a trade, the decision to use online escrow, and the fee payment arrangement, the OES adoption rate is a compound random variable of PRR that is characterized by density function $f_i(\cdot)$.

Denote the probability that a trader is honest as ρ. The probability that a seller is willing to pay the OES fee r alone in trade i can be expressed as:

$$Prob\{\xi_i \geq r, \text{“a trader is honest”}\} = \rho F_i(r). \quad (7a)$$

Similarly, the probability that a buyer is willing to pay the OES fee r alone in trade i with determined M_i and V_i^b is:

$$Prob\{\xi_i \geq rM_i/V_i^b, \text{“a trader is honest”}\} = \rho F_i(rM_i/V_i^b). \quad (7b)$$

Once two traders reach an agreement on a trade, M_i becomes common knowledge to both traders and V_i^b is known to the buyer. Then the two values are handled as constants referring to a specific trade. However, V_i^b and M_i become random variables to an OES provider facing all trades because different trades may turn out different values of V_i^b and M_i. Let us define random variables $\omega_i = V_i^b/M_i$ with a density function $w_i(\cdot)$ and ω_i is assumed independent of ξ_i. Given the assumption that a trader's PRR distribution is independent of a trader's honesty, the probability that a buyer is willing to pay OES fee r alone in trade i with unknown ratio V_i^b/M_i is:

$$Prob\{\omega_i\xi_i \geq r, \text{“a trader is honest”}\}$$
$$= P\{\omega_i\xi_i \geq r\}\, P\{\text{“a trader is honest”}\}$$

$$= \rho \int_{-\infty}^{\infty} w_i(t) P\left\{\xi_i \geq r/t \mid \omega_i = t\right\} dt$$

$$= \rho \int_{-\infty}^{\infty} [\int_{r/t}^{1} f_i(s)ds] w_i(t)dt$$

$$= \rho\, G_i(r) \qquad (8)$$

where

$$G_i(r) = \int_{-\infty}^{\infty} [\int_{r/t}^{1} f_i(s)ds] w_i(t)dt$$

is the probability that a buyer is willing to pay the OES fee r alone under the condition he or she is honest.

Finally, given an OES fee rate r, the probability that traders adopt online escrow, namely the *OES adoption probability*, is a unified distribution of the above two cases:

$$\begin{aligned} S_i(r) &= Prob\{adoption\ of\ OES\} \\ &= Prob\{\text{“}Buyer\text{-}Pay\text{”} \cup \text{“}Seller\text{-}Pay\text{”}\} \\ &= \rho\,[F_i(r) + G_i(r)] - \rho^2 F_i(r) G_i(r) \end{aligned} \qquad (9)$$

One of the important pricing strategies for an OES provider is to charge different fee rates $\mathbf{r} = \{r_j\}$ for different levels of transaction amounts having the same OES adoption probability distribution, where $j \in J$. A group of trades is defined as a *trade type* if they are in the subset $I_j \subseteq I$ with $\overline{S}_j(r_j) = S_j(r_j)$, and have a transaction amount M_{ij} that falls in a certain range called *category*. So we use $S_j(r_j)$ to represent OES adoption rate for trades in category j. To simplify the derivation, assume there is only a single type of trade in a category.

Assume each online escrow service incurs a constant cost (C^e) to an OES provider. An OES provider is willing to service trade i only if $r_j M_{ij} - C^e \geq 0$,

that is, the transaction amount $M_{ij} \geq C^e / r_j$. Therefore, in the following discussion we exclude those trades with $r_j M_{ij} < C^e$ from trade set I_j in order to simplify the objective function. The OES provider's profit maximization problem using differentiated service fee rates $\boldsymbol{r} = \{r_j\}$ is expressed as:

$$\boldsymbol{\Pi}(\boldsymbol{r}) = \sum_{j \in J} \Pi_j(r_j) = \sum_{j \in J} \max_{r_j} [(r_j \sum_{i \in I_j} M_{ij} - I_j C^e) S_j(r_j)], \tag{10}$$

where $\Pi_j(r_j)$ is the total profits from the OES for category-j trades. Maximizing each $\Pi_j(r_j)$ will eventually maximize $\boldsymbol{\Pi}(\boldsymbol{r})$, provided r_j $(j = 1, \ldots, J)$ are independent of each other.

By intuition, we know $\Pi_j(1) = 0$ and $\Pi_j(0) = 0$. When: $r_j \sum_{i \in I_j} M_{ij} > I_j C^e$, $\Pi_j(r_j)$ is non-negative. Therefore, it can be concluded that there exists at least an r_j^* such that

$$\Pi_j(r_j^*) = \max_{r_j} [(r_j \sum_{i \in I_j} M_{ij} - I_j C^e) S_j(r_j)] \tag{11}$$

where $r_j M_{ij}$ is the OES price for trade i in category j in the amount of M_{ij}, and $I_j S_j(r_j)$ is the demand for the OES in transaction amount category j.
Define

$$\overline{M}_j = \sum_{i \in I_j} M_{ij} / I_j$$

as the average trade amount for category-j trades, and

$$c_j = C^e / \overline{M}_j$$

as the average marginal cost rate for category-j trades. The average OES price can be expressed as $r_j \overline{M}_j$. The OES provider's profit from the services for category-j trades can be normalized as:

$$\pi_j(r_j) = \Pi_j(r_j) / \sum_{i \in I_j} M_{ij}$$

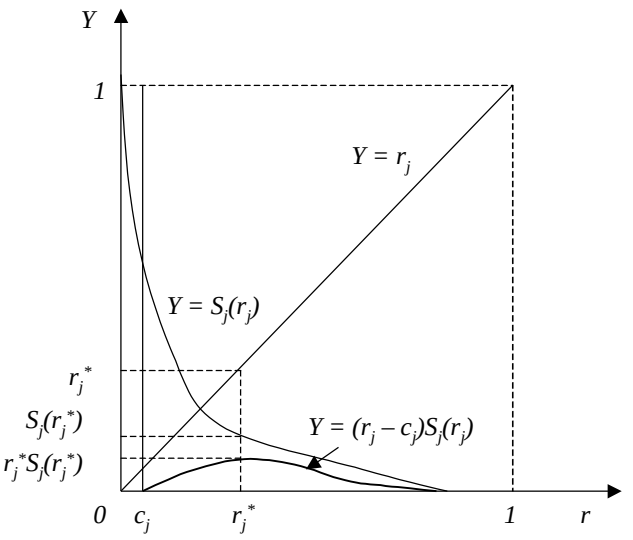
and expressed in the following simplified form:

$$\pi_j(r_j) = (r_j - c_j) S_j(r_j) \tag{12}$$

where the normalized demand from category-*j* trades is $D_j(r_j) = S_j(r_j)$, the normalized price is r_j, and the normalized marginal cost is the average marginal cost rate c_j. It is obvious $\pi_j(c_j) = 0$. A graphical representation of OES provider's profit from servicing category-*j* trades is shown in Figure 2.

If the adoption rate distribution function $S_j(r_j)$ is known, a first-order condition can be derived from equation (12) and then be solved to obtain the optimal service fee rate r_j^*. A demand-supply diagram can be further obtained using a typical microeconomic approach for a monopoly case (Hu, Lin, Whinston, & Zhang, 2001).

Figure 2. Optimal OES fee rate



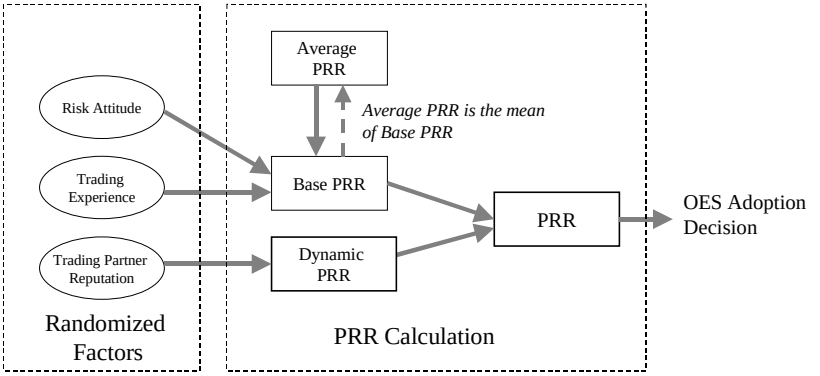
A Simulation for PRR Measurement

The measure of perceived risk is empirically important to analyze the outcomes of decisions. Earlier perceived risk measurement models use the moments of a distribution and their transformations, such as mean, variance, skewness, range, and so forth. For example, the work by Coombs and Meyer (1969), Bawa (1975), and Jean (1975) introduce lower partial moments (LPMs) reflecting the negative meaning of risk from a psychological point of view. It is a biased version compared to the previous moment-based approach. The LPMs model has been tested by Unser (2000) in an experimental study with a favorable result. A different perceived risk measurement model is proposed by Jia, Dyer, and Butler (1999) using the mean and standard risk of a decomposed lottery, which is relevant to the axiomatization of the risk theory by Pollatsek and Tversky (1970). The PRR addressed in this research, however, is dynamic and case-specific. For example, a trade only provides an opportunity to a pair of traders, while in a security market a financial product may be purchased by several traders at different moments. Therefore, our measurement model is dynamic and calculation-oriented.

In this calculative measurement model, the value of PRR is determined by two ingredients: one is the *base PRR*, which is irrelevant to a specific trade, and another is the *dynamic PRR*, which is subject to change in accordance with each trader's information about the trade. Figure 3 is a conceptual model for calculating a trade-specific PRR depending on four factors in two steps:[4]

1. Average PRR over base PRR of all traders within a certain context. This is a measure of a trader's overall perception of the risk of Internet fraud.
2. Trader's risk attitude. This factor is referred to as the deviation of risk perception. It reflects the effect of a trader's personality on risk assessment and is represented as the range in which the deviation is uniformly distributed.
3. Trader's experience of losses in online trades. This factor captures the effects of a trader's previous losses on the current PRR estimation. The longer the duration since the last loss happened before the current trade, the less the effect it imposes.

Figure 3. Measurement model for PRR



4. Trading partner's reputation. Most auction sites provide the historical records of a trader. This is a useful source that can be used to estimate a trading partner's reputation.

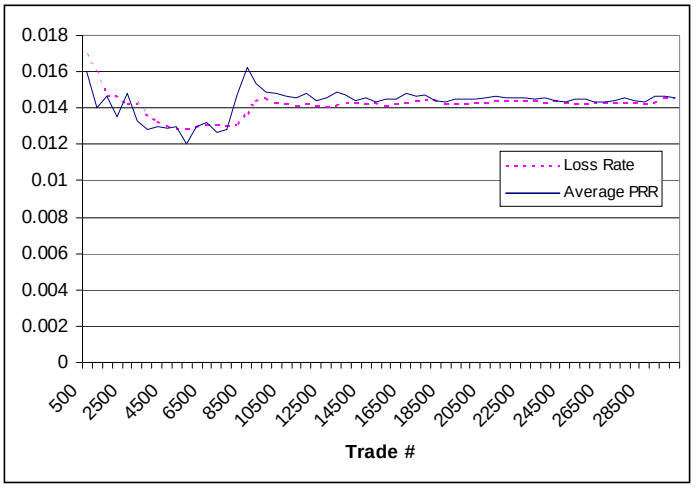
Denote $A\text{-}PRR_t$ $B\text{-}PRR_t$, and $D\text{-}PRR_t$ for average PRR, base PRR, and dynamic PRR, respectively, in trading time frame *t*. A trader's PRR in trade *i* in trading time frame *t* is formalized as:

$$PRR_i = \Phi_i[\Phi_t^B(A\text{-}PRR_{t-1}, \tau, \gamma), \Phi_t^D(Repu)]$$

where τ is the factor of personal trading loss factor, γ is the trader's risk preference factor, $B\text{-}PRR_t = \Phi_t^B(A\text{-}PRR_{t-1}, \tau, \gamma)$ is a function of $A\text{-}PRR_{t-1}$, τ and γ, $A\text{-}PRR_{t-1}$ is an average of $B\text{-}PRR_{t-1}$ over traders, and $D\text{-}PRR = \Phi_t^D(Repu)$ is a function of the trading partner's reputation factor *Repu*.[5]

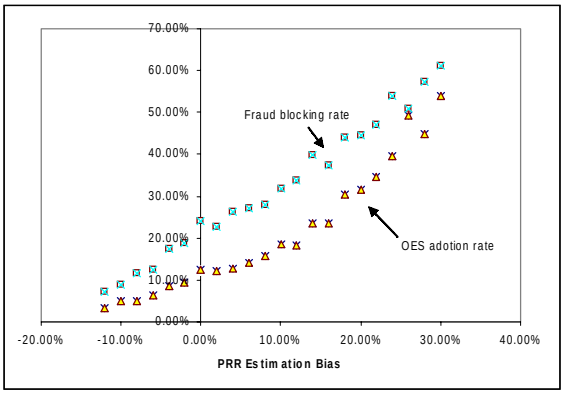
The simulation program accesses a pool of 160 traders. Each trader is assigned an initial base PRR ranging from 0.015 to 0.03, and the OES fee rate is preset as 2% of the transaction amount. That is, $B\text{-}PRR_0$ is uniformly distributed at the beginning. Instances of Internet fraud are randomly generated among trades. Traders, either sellers or buyers, decide the adoption of online escrow if they are of honest type. Then $A\text{-}PRR_t$, $B\text{-}PRR_t$ $D\text{-}PRR_t$ and PRR_i are recursively calculated. Figure 4 shows that $A\text{-}PRR_t$ converges to the loss rate, which is the observable indicator as the rate of committed fraud.

Figure 4. Dynamics of average PRR (A-PRR$_t$)

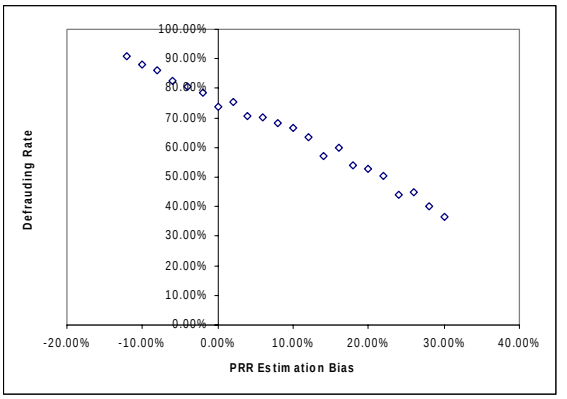


We further tested the sensitivity of simulation outcomes to the deviation of PRR estimate. Normally the value of PRR should be close to the loss rate because it is the estimate of the latter. Their ratio can be viewed as an indicator for the accuracy of the estimation. According to the PRR calculation formula PRR directly affects the OES adoption that finally suppresses fraud. However, since the resulted lower loss rate will conversely reduce PRR, there exists a dynamic equilibrium when the PRR estimate is deviated from the loss rate (either overestimating or underestimating the real situation). Define *fraud rate* as the probability that a fraud may happen in an online C2C trade, *defrauding rate* as the probability that a cheating-type trader decides to cheat in a trade, and *fraud blocking rate* as the probability that the adoption of OES will block a fraud attempt. The experiment shows that given a fraud rate, the deviation of PRR estimate positively affects the OES adoption rate and the fraud blocking rate (Figure 5a) and negatively affects the defrauding rate (Figure 5b). However the fraud blocking rate curve is flatter than the OES adoption rate. This indicates that although the overestimation of PRR increases the OES adoption rate, it may not be socially optimal.

Figure 5. Effect of PRR estimation on OES market equilibrium (fraud rate = 2%)



(a) Sensitivities of OES adoption rate and fraud blocking rate to PRR estimation deviation from loss rate.



(b) Sensitivity of defrauding rate to PRR estimation deviation from loss rate.

Conclusions

This chapter shows the results of studies of the OES adoption problem for the honest trader and the OES fee optimization problem for the monopolist OES provider in Internet-based C2C auction markets. PRR, the subjective estimate of online trading risk, is used to link together the models for OES demand and supply sides. In adopting online services for electronic commerce, PPR becomes the driving factor in using the financial assurance services of a trusted

third party, and the reduced risk under the protection of such a service improves the trustworthiness of the online auction marketplace. We briefly introduce a calculative model for PRR with a two-step recursive calculation. The converging PRR from the simulation shows a normal-like distribution in a stable status.

Further theoretical research should achieve two objectives. The first one is to complete a game theoretic model by introducing a cheater-based decision-making process. This will be a sequential signaling game model with extensive sub-game, perfect Nash equilibrium analyses. The second objective is to further explore the relationship between perceived risk in using an online facility and the facility's trustworthiness (for example, Kim & Prabhakar, 2000). The OES provides a good setup to explore that relationship when a TTP is present.

Moreover, promising outcomes may also come from empirical studies. One aspect is to conduct comprehensive computer experiments to study the relationship among PRR, OES adoption rate, fraud rate, and OES fee rate. Both computer simulation and human-based experiments could be carried out. In addition, from a behavioral point of view, the causal relationship between the underlying factors and PRR could be another interesting research issue in the next stage.

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Endnotes

1 See *http://news.com.com/2100-1017-898154.html* (last accessed on August 10, 2004).

2 The case of "joint payment" for the OES simply increases mathematical complexity with the same theoretical conclusions.

3 For example, eBay has entered into an alliance with Escrow.com (*www.escrow.com*).

4 The properties of merchandise should be one of the factors in PRR estimation. This model assumes that PRR is indifferent to this factor to reduce the complexity of analyses.

5 Due to the limited size of the chapter, detailed information about relations between components in Figure 3 has been omitted.

Chapter VII

Inter-Firm Collaboration and Electronic Business: Effects on Profitability in Finland[1]

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Abstract

This chapter studies the joint effects of inter-firm collaboration and electronic business on firm profitability primarily in Finnish manufacturing. It is found that deeper forms of inter-firm collaboration boost financial performance but that high e-business intensity might even strain profitability. Firms that simultaneously have high inter-firm collaboration and e-business intensities as well as use electronic networks for conducting their collaboration are also more profitable. Based on this, two conclusions are drawn. First, suitable e-business practices facilitate inter-firm

collaboration. Once in place, inter-firm collaboration tends to be immensely more productive with supporting electronic means. Second, e-business investment has to be accompanied by complementary organizational innovations, in this case a new form of external (and also internal, although not observed directly in the data used) organization of the firm, that is, inter-firm collaboration.

Introduction

Due to increasing technological speed of change and complexity as well as intensifying global competition, firms are keenly concentrating on their core competences. As a direct consequence, inter-firm collaboration is becoming an increasingly important part of firms' business activities. Many previously strategic in-house functions, such as electronics manufacturing, have now been commoditized to the extent that maintaining own capacity hardly seems worthwhile even for relatively large firms.

Nowadays literally any business function can be outsourced. Some firms have done so to the extent that discussion on the hollowness of modern corporations is indeed warranted. The level of commitment in inter-firm collaborative arrangements varies greatly. Most of them are perhaps best likened to market transactions, but deeper forms are also quite prevalent. In an extreme case interests of parties involved are inseparable; effectively they form a new business entity, but technically organizational boundaries still exist.

A well-managed portfolio of collaborative arrangements can be a real and lasting source of competitive advantage, as it makes the firm more flexible and lean as well as puts a more diverse set of resources at its disposal. It is not far-fetched to argue that in the future it might be networks of firms rather than monolith corporations that compete in the global marketplace. On the flip side, inter-firm collaboration makes the parties involved inter-dependent and exposes them to new risks. Also in this case the chain is only as strong as its weakest link, but contrary to the case of internally management functions, no single party has a direct mechanism to oblige desired behavior.

In this chapter we implicitly focus on vertical inter-firm collaboration, that is, on connections to up- and downstream industries. This focus is primarily driven by the definitions of the collaboration-related explanatory variables. Horizontal inter-firm collaboration (for example, strategic alliances) does not typically

involve significant goods and/or service flows between the parties involved, as the firms are by definition in the same industry. This is also likely to be the case for diagonal inter-firm collaboration between parties in unrelated industries.

The mushrooming of inter-firm collaboration has been driven in part by rapid advances in information on communication technologies (ICTs). Real-time coordination of geographically and organizationally dispersed business activities has only recently become sufficiently cost effective for a wide range of businesses. On the other hand electronic business (e-business) practices have often followed rather than led the developments; that is, inter-firm collaboration was becoming increasingly common even before the ICT boom of the 1990s and was not necessarily tied to introductions of new e-business practices. In many cases new electronic tools have nevertheless been welcomed aids in the ongoing collaboration.

Designing e-business practices to suit the needs of a given organization is not a trivial task. The task is immensely more complex when several organizations are involved. Not necessarily coordinated by nevertheless aligned decisions have to be made on, for example, communications platforms and interfaces as well as on business process reengineering. The collective associated investments are substantial and in considerable part sunk, that is, unrecoverable, if collaboration was to be discontinued. Thus e-business may be seen as an agitator, enabler, and/or enforcer in inter-firm collaboration.

In what follows we study inter-firm collaborative arrangements and e-business practices in tandem. We focus on their profitability effects among Finnish business enterprises primarily in manufacturing industries.

Literature

As pointed out by Gulati, Nohria, and Zaheer (2000), in the current literature on inter-firm collaboration financial performance considerations are largely ignored. The few studies that do touch upon the issue are not directly comparable and provide mixed evidence. Bastos (2001) finds no conclusive evidence of the performance effects of collaboration. Both Chung and Kim (2003) and Claro, Hagelaar, and Omta (2003) suggest that deeper forms of inter-firm collaboration are associated with better performance. Soh (2003) finds that performance improves with the number of repeated partners and relative "centrality" in the collaborative arrangement.

While macroeconomic effects of ICT (see, for example, Gordon, 2000; Jorgenson, 2001; Oliner & Sichel, 2000) have perhaps been the most-discussed issue in the new economy literature, there is relatively large and growing literature on microeconomic effects as well (reviewed in, for example, Brynjolfsson & Hitt, 2000; Dedrick, Gurbaxani & Kraemer, 2003; OECD, 2003). The available firm-level evidence suggests that the performance effects of ICT greatly depend on the implementing firms' ability to reengineer their business processes and introduce complementary organizational innovations. To our knowledge external organizational choices, that is, inter-firm collaborative agreements, have not been studied in this context.

Articles considering both inter-firm collaboration and e-business are quite rare. Lee and Lim (2003) study the use of electronic data interchange (EDI) and involved firms' partnership attributes. They find that the extent of EDI integration, exchange, and performance is higher in deeper relationships. Lee, Pak and Lee (2003) contrast basic and collaborative business-to-business (B2B) electronic commerce (e-commerce). In basic B2B e-commerce, firms merely computerize commercial transactions. In collaborative B2B e-commerce, electronic networks are used to facilitate inter-firm collaboration. The survey findings suggest that the source of performance improvements is not the B2B e-commerce in itself but rather the inter-firm collaboration it enables. Neither of these studies explicitly focuses on the ultimate performance effect from a firm's point of view, that is, profitability.

We are unaware of any prior studies that would closely resample our work, although the volume and co-existence of inter-firm collaboration and e-business practices clearly calls for such work.

Data

The stellar economic performance of Finland in recent years is in considerable part attributable to ICT-related developments (Rouvinen & Ylä-Anttila, 2003). These developments were aided by intense intra- and inter-sector interactions, which by many studies (see, for example, EU, 2000; OECD, 1999) are characteristic to the Finnish national innovation system (Georghiou, Smith, Toivanen & Ylä-Anttila, 2003). Jalava and Pohjola (2002) show that in aggregate terms Finland is among the leading new economies, that is, the absolute macroeconomic effects of ICT in the late 1990s were quite similar to

those in the United States. As distinct from the U.S. experience, however, the Finnish effects are mostly mediated via ICT provision as opposed to ICT use. Maliranta and Rouvinen (2003a, 2003b) find that the average firm-level effect of ICT in Finland closely corresponds to the mean estimate calculated across available international studies. Thus Finland should provide an interesting test bed in quantifying the joint effects of inter-firm collaboration and e-business. The context is not entirely unlike in other industrialized countries, although generalizations should be made with caution.

The key sources of information for our study are two rather unique and extensive surveys conducted by the Confederation of Finnish Industry and Employers (TT) in Finland. In spring 2000 the electronic business survey collected quantitative data on the adoption of e-business practices in various corporate functions. The survey was sent to approximately 500 Finnish primarily manufacturing firms, and 360 responses were received — together they represent roughly half of Finnish manufacturing in terms of sales volume and employment. In early 2001 the corporate networks survey addressed various aspects of inter-firm collaborative arrangements: how common they are, what are the underlying factors, what kind of problems are associated with it, and what are their effects. The survey form was sent to approximately 700 companies, and 363 responses were received — together they represent more than half of Finnish manufacturing in terms of sales volume and employment.

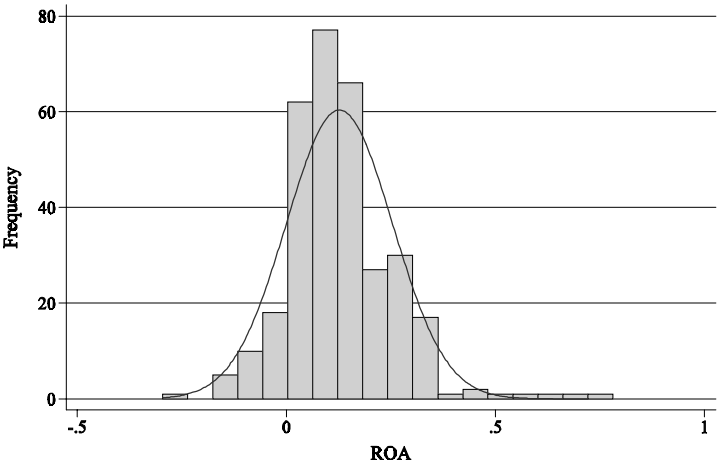
While both surveys have been conducted only once, we do observe e-business expenditure from 1998 to 2000 thanks to some retrospective questions in the survey. After three-way matching of the two surveys and Balance Consulting's financial statement database, we are left with a three-year balanced quasi panel of 107 firms (82 in manufacturing) and 321 observations.[2]

Our dependent variable is return on assets (ROA), ratio of net income to total assets, which is a common measure of firm performance. It is calculated as follows:

$$\text{ROA} = \frac{\text{pre-tax profits before extraord. items \& appropriations + financial expenses}}{\text{total assets}}. \quad (1)$$

ROA tells how well the firm uses its assets to produce income. The ratio tends to be high for firms having high sales margins and for firms generating high sales

Figure 1. A histogram of the return on assets (ROA) observations (with an overlay of a normal distribution)



Note: ROA is a continuous variable. The number of bins (k) in the histogram determined according to the following standard formula: (Stata version 8): $k = \min\{\sqrt{N}, 101\text{n}(N)/\ln(10)\}$, *where N is the number of observations.*

volume relative to their assets. ROA is a relatively standard measure of firm performance (Barnett, Greve, & Park, 1994).

The sample mean of ROA is 12.7%, which is quite high but not unusual in economic upturns. It seems to be reducing over time: Year 1998 mean is 13.7% whereas year 2000 mean drops to 11.6%. For roughly 1/10 of observations ROA is negative. Figure 1 shows a histogram of ROA observations.

The control variables include (natural logarithm of) sales (in millions of euros and year 2000 prices), firm age (years elapsed since the firm was established), a dummy for the firm being established recently (less than three years ago), sales growth from the previous year as well as industry (with other industries as the reference group)[3] and time (with year 2000 as the reference) dummies.

Three indicators of inter-firm collaboration are considered: its extent — the inter-firm collaboration intensity (the share of sales generated via inter-firm collaborative agreements),[4] its depth — the share of long-term commitments (the share of partnership-like long-term networking commitments),[5] and its organization — a dummy of having a mutual written collaboration strategy.[6]

Three measures of e-business practices are included: e-business intensity (the ratio of e-business investments to sales),[7] a dummy for having online sales,[8] and

a dummy for using electronic networks for inter-firm collaboration (e-collaboration).[9]

The final variable, and perhaps the one of greatest interest, is a three-way interaction term of the inter-firm collaboration intensity, the e-business intensity, and the e-collaboration dummy.

Table 1. Descriptive statistics of the sample (107 firms, 321 observations)

Variable	Description	Mean	St. dev.	Min.	Max.
Firm	Firm identification code			1	107
Year	Observation year			1998	2000
Profitability	Return on assets, ROA	0.127	0.127	-0.296	0.721
Sales	Log of net sales in mill. • & 2000 p.	3.263	1.804	0.038	9.531
Age	Years elapsed since founded	25.841	33.678	0	164
New	Dummy for new firms, <3 years old	0.016	0.124	0	1
Growth	Sales growth	0.148	0.560	-0.649	9.134
Collaboration	Inter-firm collaboration intensity	0.328	0.364	0	1
Partnership	Share of long-term commitments	0.286	0.314	0	1
Strategy	Dummy for having a written strategy	0.570	0.496	0	1
e-business	e-business intensity	0.005	0.014	0	0.110
e-commerce	Dummy for having online sales	0.280	0.450	0	1
e-collaboration	Dummy for e-collaboration	0.785	0.411	0	1
Interaction	Collaboration * e-business * e-collab.	0.001	0.004	0	0.044
Ind., Food	Ind. dummy: Foodstuffs, bev., tobacco	0.056	0.230	0	1
Ind., Textiles	Ind. dummy: textiles, apparel, leather	0.093	0.292	0	1
Ind., Paper etc.	Ind. dummy: Pulp, paper, publishing	0.112	0.316	0	1
Ind., Chemical	Ind. dummy: Chemicals	0.112	0.316	0	1
Ind., Minerals	Ind. dummy: Metals, non-met. miner.	0.075	0.263	0	1
Ind., Met. prod.	Ind. dummy: Metal products	0.084	0.278	0	1
Ind., Machinery	Ind. dummy: Machinery, transp. equip.	0.159	0.366	0	1
Ind., Electrical	Ind. dummy: electrical & electronic eq.	0.056	0.230	0	1
Ind., Constr.	Ind. dummy: construction	0.056	0.230	0	1
Ind., Biz serv.	Ind. dummy: IT & other business serv.	0.121	0.327	0	1
Year, 1998	Time dummy, year 1998	0.333	0.472	0	1
Year, 1999	Time dummy, year 1999	0.333	0.472	0	1

Note: See Endnotes 4-9 for further details on the inter-firm collaboration and e-business variables.

Table 1 shows basic descriptive statistics of our sample data. Year 2000 sales of the firms in the sample range from 1.3 million to 13 billion euros with a mean of a good 300 million euros. The sample firms are on average more than a quarter of a century old; only 1.6% of the sample firms are recently established. At almost 15%, the mean sales growth of the sample firms is quite brisk in the observation period.

On average nearly one-third of the firms' sales are generated via inter-firm collaborative agreements. A more detailed look reveals that the distribution is skewed: almost 1/3 of the firms have no sales of this type; for roughly 1/10 of the firms all sales are generated via such agreements. The mean share of partnership(s) in inter-firm collaboration is more than 1/4, but again the distribution is skewed: for close to 40% of the firms this share is zero; the remaining observations are relatively evenly distributed across the range. Nearly 60% of the firms report that written rules of engagement exist for one or more of their inter-firm collaborative agreements.

E-business investments are on average about 1/2 a percent of sales. One-fifth of the sample has not made any e-business investments. About 1/4 of the samples firms have online sales. More than 3/4 exploit electronic networks in their collaboration with other firms.

Foodstuffs, beverages, and tobacco is the smallest industry in our sample, accounting for less than 6% of the observations. Machinery and transport equipment is the biggest industry in our sample, accounting for 16% of our sample.

Table 2 shows pair-wise correlations of the variables. The inter-firm collaboration intensity and partnerships are positively associated with growth. Deeper forms of collaboration are associated with better profitability. E-business intensity tends to be higher among smaller firms.

The 1998-2000 period under consideration here is quite exceptional in many respects. We control for macroeconomic shocks by including time dummies in our regression. While this alleviates the problem considerably, it does not completely remove it.

As our data is derived by matching three sources of data that are not even initially completely random, obviously our sample is somewhat selected. It has a bias toward larger firms. The sample firms represent 1/3 of Finnish manufacturing sales and less than 1% of sales in Finnish construction and services in year 2000.

Table 2. Pairwise correlations of variables

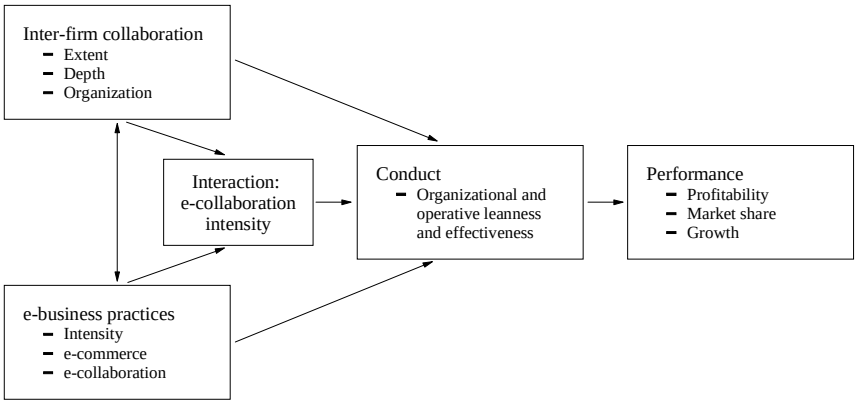
	Profitability	Sales	Age	New	Growth	Collaboration	Partnership	Strategy	e-business	e-commerce	e-collaboratior	Interaction
Profitability	1											
Sales	0.05	1										
Age	0.02	0.06	1									
New	-0.08	0.05	-0.09	1								
Growth	0.18*	0.05	-0.07	-0.01	1							
Collaboration	0.03	0.07	-0.13*	0.02	0.12*	1						
Partnership	0.15*	0.07	0.00	-0.07	0.12*	0.33*	1					
Strategy	-0.02	0.05	0.09	0.01	-0.05	0.37*	0.08	1				
e-business	-0.03	-0.27*	-0.09	0.00	-0.01	-0.01	0.00	0.02	1			
e-commerce	-0.03	0.24*	0.12*	-0.02	-0.01	0.05	0.312*	0.08	-0.04	1		
-collaboration	0.03	-0.01	0.05	-0.12*	0.03	0.05	0.18*	0.10	-0.07	0.28*	1	
Interaction	0.04	-0.21*	-0.08	-0.01	-0.01	0.22*	0.01	0.20*	0.60*	0.00	0.16*	1

Note: Star (*) indicates the statistical significance of the correlation at 5% level.

Analysis

Figure 2 shows our stylized research model. It is hypothesized that inter-firm collaboration and e-business practices bring about organizational and operative leanness and effectiveness among the involved firms, especially if the two co-exist and interact. They in turn contribute to better performance.

Figure 2. Stylized research model



We operationalize the above model by defining the following empirical specification for firm *i* at time *t*:

$$\begin{aligned}\text{Profitability}_{i,t} = {} & \beta_0 \text{ Constant} \\ & + \beta_1 \text{Sales}_{i,t} + \beta_2 \text{ New}_{i,t} + \beta_1 \text{ Age}_{i,t} + \beta_1 \text{ Growth}_{i,t} \\ & + \beta_{5\text{–}14} \text{ Industry}_i + \beta_{15\text{–}16} \text{ Year}_t \\ & + \beta_{17} \text{ Collaboration}_i + \beta_{18} \text{ Partnership}_i + \beta_{19} \text{ Strategy}_i \\ & + \beta_{20} \text{ e-business}_{i,t} + \beta_{21} \text{ e-commerce}_i + \beta_{22} \text{ e-collaboration}_i \\ & + \beta_{23} \text{ Interaction}_{i,t} + \varepsilon_{i,t}\end{aligned} \quad (2)$$

where ε is the error term. We use the fully robust pooled ordinary least squares (OLS) estimator to derive our core results. Fully robust refers to the fact that we employ White (1980) heteroscedasticity consistent standard errors and also allow for the dependence (autocorrelation) of observations across *t*. Thus, the measurement of standard errors is robust as long as *i*'s are independently distributed (for discussion, see Stata, 2001, section 23.11). We will also consider other estimators in order to study the sensitivity of our results.

Results

Table 3 presents our core results. As can be seen, we do not find evidence for size (Sales) or growth effects. Understandably recently established firms (New) tend to be less profitable. Otherwise firm age does not have an effect on profitability.

Profitability seems to be higher in the chemicals industry (Ind., Chemical), construction (Ind., Constr.), and business services (Ind., Biz serv.). There is some indication that profitability is also higher in minerals and metals (Ind., Minerals) as well as in electrical and electronic industries (Ind., Electrical), although they just miss the mark of being significant at the 10% level. Time dummies reflect the trend of the dependent variable already discussed above.

Table 3. Estimation of the profitability model (dependent variable: ROA) – pooled OLS with fully robust standard errors

Constant	0.011	Ind., Food	-0.039
	(0.057)		(0.055)
Sales	0.007	Ind., Textiles	0.048
	(0.010)		(0.048)
New	-0.109**	Ind., Paper etc.	0.051
	(0.047)		(0.049)
Age	0.000	Ind., Chemical	0.109*
	(0.000)		(0.058)
Growth	0.022	Ind., Minerals	0.081
	(0.021)		(0.053)
Collaboration	-0.027	Ind., Met. prod.	0.037
	(0.032)		(0.056)
Partnership	0.085*	Ind., Machinery	0.043
	(0.044)		(0.051)
Strategy	-0.009	Ind., Electrical	0.134
	(0.021)		(0.083)
e-business	-1.359*	Ind., Constr.	0.116*
	(0.762)		(0.059)
e-collaboration	-0.001	Ind., Biz serv.	0.128*
	(0.028)		(0.065)
e-commerce	-0.020	Year, 1998	0.024*
	(0.021)		(0.013)
Interaction	3.200	Year, 1999	0.015
	(2.071)		(0.010)
Observations		321	
R-squared		0.20	

*Note: ***, **, and * respectively indicate significance at 1, 5, and 10 % level. Standard errors in parentheses.*

The extent of inter-firm collaboration per se does not have a statistically significant effect on profitability. In fact the coefficient estimate itself is negative, although no conclusion can be drawn on that due to the rather large standard error. The depth of the collaboration (Partnership) has, however, a large positive effect on profitability (the exact significance level is 5.5%). Having explicit "rules of engagement" (Strategy) does not have an effect on profitability.

High e-business intensity strains profitability. In fact the coefficient estimate suggests that in a typical case e-business investments are wasted, that is, they reduce profits by roughly the amount of invested. Having online sales (e-commerce) or using electronic networks for inter-firm collaboration (e-collaboration) do not contribute to profitability.

Recall that the interaction term is, first, non-zero only for firms using electronic networks for inter-firm collaboration, and, second, the highest for firms that are intensively engaged in both inter-firm collaboration and e-business. Thus it should proxy quite well the use of e-business practices in inter-firm collaboration, although this is not observed directly. Also note that any problems with this proxy will bias us against finding significant results. Somewhat disappointingly, the interaction terms fail marginally to be significant at 10%.

In the following few sections we will discuss the robustness of the above findings. We consider the roles of time dimension, firm effects, and outliers.

Time Dimensions and Firm Effects

As discussed above, we have a quasi panel at our disposal, that is, some variables are not observed across time. An alternative approach would have been to estimate the model with cross-sectional data, although some information would have been thrown away. In the four leftmost columns of Table 4 we derive the results separately for each of the three years as well as by averaging the three annual observations for each of the firms (the between estimator).

The findings in the results section are consistent in large samples with relatively weak set of assumptions (see, for example, Wooldridge, 2002, sections 7.8.1–3). It is nevertheless true that pooled OLS is biased and inconsistent if the firm effect is correlated with any of the explanatory variables in Equation (2). In the rightmost column of Table 4 the fixed-effects, or within estimator (also known as the least squares dummy variable or the covariance estimator), is used to remove the firm effects.

Table 4 largely confirms the findings of the results section. Partnership is (close to being) significant if estimable. Many coefficients are not estimable with the within estimator, but the results nevertheless show that the findings on the effects of e-business intensity and its interaction with respect to inter-firm collaboration are not driven by unobserved firm heterogeneity.

Table 4. Estimations of the profitability model for years 1998, 1999, and 2000 (robust OLS) as well as the between and within estimates

Dependent variable: Profitability (ROA)	Rob. OLS Year 1998	Rob. OLS Year 1999	Rob. OLS Year 2000	Between Estimator	Within Estimator
Constant	0.059	0.004	0.004	0.020	0.043
	(0.080)	(0.057)	(0.064)	(0.050)	(0.299)
Sales	0.007	0.008	0.008	0.009	0.063**
	(0.010)	(0.010)	(0.012)	(0.007)	(0.028)
New	-0.112**	-0.188***	0.000	-0.309**	0.067
	(0.053)	(0.037)	0.000	(0.132)	(0.041)
Age	0.000	0.001*	0.001**	0.000	-0.005
	(0.000)	(0.000)	(0.000)	(0.000)	(0.011)
Growth	0.011	0.208***	0.010	0.060	0.006
	(0.013)	(0.059)	(0.079)	(0.038)	(0.008)
Industry dummies	Yes	Yes	Yes	Yes	No
Time dummies	No	No	No	No	Yes
Collaboration	-0.030	-0.017	-0.021	-0.024	
	(0.040)	(0.036)	(0.033)	(0.037)	
Partnership	0.068	0.094**	0.067	0.075*	
	(0.053)	(0.047)	(0.047)	(0.040)	
Strategy	-0.012	-0.014	0.000	-0.002	
	(0.026)	(0.023)	(0.023)	(0.026)	
e-business	-1.989	-0.170	-1.218	-0.280	-7.203***
	(1.401)	(0.737)	(0.876)	(1.225)	(0.946)
e-collaboration	-0.011	-0.001	0.020		
	(0.039)	(0.028)	(0.036)	(0.029)	
e-commerce	-0.012	-0.029	-0.022	-0.019	
	(0.026)	(0.026)	(0.024)	(0.027)	
Interaction	4.224	-0.708	3.926	1.497	17.107***
	(4.089)	(3.480)	(2.775)	(3.532)	(3.567)
Observations	107	107	107	107	321
R-squared	0.23	0.40	0.19	0.28	0.26

*Note: Rob. refers to White (1980) heteroscedasticity consistency. ***, **, and *, respectively, indicate significance at 1, 5, and 10 % level. Standard errors in parentheses. Industry dummies are either included but not reported (Yes) or not estimable (No).*

Outliers

It is not unusual in regression analysis that the findings are driven by a few extreme observations. We study this possibility by considering two alternative ways of dealing with the outliers: We employ an outlier robust OLS estimator as suggested in Li (1985), with technical details discussed in Hamilton (1991),

and alternatively winsorize our data, that is, for some variables replace the lowest and/or highest (as indicated in Table 5) 1% of the variable values by the next value counting inward from the extremes (Barnett & Lewis, 1994).

As can be seen in Table 5, accounting for outliers seems to strengthen the findings in the core results section. Also the interaction term is statistically significant in the winsorized case (significant at 20% level with the outlier robust estimator).

Table 5. Estimations studying the role of outliers

Dependent variable: Profitability (ROA)	OLS Outlier rob.	Dependent var.: ROA (Lowest and highest 1% winsorized)	OLS Fully rob.
Constant	0.035	Constant	0.022
	(0.029)		(0.051)
Sales	-0.003	Sales (Lowest and highest 1% winsorized)	0.003
	(0.004)		(0.008)
New	-0.093*	New	-0.104**
	(0.048)		(0.049)
Age	0.000**	Age (Highest 1% winsorized)	0.000
	(0.000)		(0.000)
Growth	0.104***	Growth (Lowest and highest 1% winsorized)	0.132***
	(0.025)		(0.044)
Industry dummies	Yes	Industry dummies	Yes
Time dummies	Yes	Time dummies	Yes
Collaboration	-0.010	Collaboration	-0.025
	(0.020)		(0.029)
Partnership	0.061***	Partnership	0.076*
	(0.022)		(0.039)
Strategy	0.009	Strategy	-0.007
	(0.014)		(0.019)
e-business	-1.508**	e-business (Highest 1% winsorized)	-1.428*
	(0.614)		(0.736)
e-collaboration	0.012	e-collaboration	-0.003
	(0.016)		(0.025)
e-commerce	-0.033**	e-commerce	-0.023
	(0.015)		(0.020)
Interaction	2.409	Interaction (Highest 1% winsorized)	4.655*
	(1.841)		(2.694)
Observations	320	Observations	321
R-squared	0.23	R-squared	0.25

*Note: ***, **, and *, respectively, indicate significance at 1, 5, and 10 % level. Standard errors in parentheses.*

Conclusions

Economic theory suggests that in the presence of free entry and exit, supernormal profits are unlikely to occur unless there are firm-specific assets or resources that are not generally and widely available. Thus it is hardly surprising that "standard" inter-firm collaboration or e-business investment does not seem to contribute to profitability. Specific dimensions of either one or a unique combination of the two can nevertheless be a source of sustained competitive advantage.

While inter-firm collaboration as such does not boost profitability, deeper forms of collaboration or partnerships do. One interpretation of this finding is that only after the parties involved are committed to the collaboration, are they willing to take the risk of reengineering their internal and external business processes to exploit the ongoing collaboration to the fullest. Without such reengineering, some of the potential benefits are foregone. It seems that only partnerships are win-win situations, where the fruits of the collaboration are justly distributed, in which case the relative centrality in the collaborative network looses some of its meaning (Soh, 2003). There is also a more practical explanation, although its financial significance remains to be evaluated: a long-term commitment simply economizes on transactions costs among the collaborating parties as contracts have to be negotiated less frequently. In any case it matters a great deal in what spirit the collaboration is being conducted. Obviously forming and maintaining fruitful partnerships is not easy. Indeed, as suggested by our data, inter-firm collaboration is quite prevalent but deeper forms are considerably less so.

Our results suggest that high e-business intensity might even strain profitability. Admittedly, however, we are unable to study the adjustment process associated with e-investments due to our short time span. Massive e-business investment took place in the late 1990s, but its effects are not necessarily unveiled yet. We have anecdotal evidence that the lags from e-investment to its full effects might be considerable. Cisco Systems Inc. CEO John T. Chambers has argued that "… the greatest payoff doesn't come until seven to nine years after an [e-business] investment is made" (*Business Week*, 17 Feb. 2003, p. 45). Brynjolfsson and Hitt (2002) indirectly suggest that the lag is from three to seven years. With such lags we would have observed only the immediate negative effect of e-investments in our analysis. In hindsight it can nevertheless be said that some e-investments of the late 1990s are doomed to be unprofit-

able but perhaps to a lesser extent among established manufacturing firms — as our descriptive statistics indicate, even in the heyday of the new economy e-investment remained on average relatively modest among the sample firms.

Our results confirm that the heart of the matter lies in having a suitable mix of inter-firm collaboration and e-business practices. Firms that simultaneously have high inter-firm collaboration and e-business intensities as well as use electronic networks for conducting their collaboration are also more profitable. We interpret this as a sign of two things. First, suitable e-business practices facilitate inter-firm collaboration. Once in place, inter-firm collaboration can be immensely more productive with supporting electronic means. Second, e-business investment has to be accompanied by complementary organizational innovations, in this case a new form of external (and undoubtedly also internal, although we do not observe it directly) organization of the firm, that is, collaboration.

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Endnotes

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2 All inter-firm collaboration and most e-business variables are not observed across time.

3 The specified industries comprise the following TOL95 industrial classification groups: Food (foodstuffs, beverages, tobacco – 15, 16); Textiles (textiles, apparel, leather, footwear – 17, 18, 19); Paper and so forth (wood and wood products, pulp and paper, publishing and printing – 20, 21, 22); Chemical (coke and nuclear fuel, chemicals, rubber and plastics – 23, 24, 25); Minerals (non-metallic minerals and basic metals – 26, 27); Metal products (fabricated metal products – 28); Machinery (machinery and equipment, transport equipment – 29, 34, 35); Electrical (electrical equipment and machinery, communications equipment, instruments – 30, 31, 32, 33); Construction (45); Business services (computer and related activities, other business service activities – 72, 74). The remaining observations (less than one-fifth of the total) fall into the control group.

4 Section 5 of the corporate networks survey inquires about the scope and depth of inter-firm collaboration. The preceding Section 4 asks about the firm's relative position in its collaborative network. Subsection 5.1 includes two questions, one specific to the firm's relative position defined in Section 4 and one referring to other types of inter-firm collaboration. As we want to abstract somewhat from the fine points of networking and discuss inter-firm collaboration in general, we combine the answers to the two questions. Thus our measure is effectively the firm's self-reported perception on the following question (divided by 100): What percentage of your firm's productive turnover is related to inter-firm collaboration?

5 Subsection 5.2. of the corporate networks survey concerns the composition of inter-firm collaboration by type of contract. The firm is asked to report the distribution of its inter-firm collaboration-related sales across five categories: (a) partnership, (b) annual, (c) project, (d) one-off, and (e) other types of contracts. Partnerships are understood as long-term companionships that both parties are committed to. Our measure is the firm's self-reported perception on the following question (divided by 100): What percentage of your firm's inter-firm collaboration -related sales is derived via contract(s) best characterized as partnerships?

6 Section 8 of the corporate networks survey concerns the operating principles of inter-firm collaboration. It is, among other things, inquired whether the firm has explicit written contract(s) concerning the strategy of its bi-/multilateral inter-firm collaboration. Our measure is the firm's self-reported perception on the following question: Does your firm have

written contract(s) on the operating principles of inter-firm collaboration in the following categories: strategy? (Yes or No.)

[7] Adopted from Section 3 of the e-business survey inquiring on the firm's e-business investments (defined to included hardware, software, training, acquired services, and personnel expenditures) for various years.

[8] Section 1 of the e-business survey concerns the use of electronic business practices across various business functions. Section 1.e concerns the sales of own products. Our measure is the firm's self-reported perception on the following question: What is your estimate on the percentage share of electronic business practices in the following functions: sales of own products? (Please check one of the following categories: do not know, 0%, under 2%, 2-5%, 5-10%, 10-30%, over 30%). The firm is interpreted to have online sales if one of the following categories is chosen: 2-5%, 5-10%, 10-30%, or over 30%.

[9] Section 1.f of the e-business survey concerns information transfer(s) between collaborating parties. Our measure is the firm's self-reported perception on the following question: What is your estimate on the percentage share of electronic business practices in the following functions: information transfer(s) between collaborating parties? (Please check one of the following categories: do not know, 0%, under 2%, 2-5%, 5-10%, 10-30%, over 30%). The firm is interpreted to use electronic networks for inter-firm cooperation if one of the following categories is chosen: 2-5%, 5-10%, 10-30%, or over 30%.

Chapter VIII

Pay Now or Later?
The Impact of Temporal Separation of Payments and Consumption on Consumer Payment Preferences

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Abstract

In this chapter, we draw on the behavioral economics literature to identify the conditions under which consumers would prefer one of three pricing schemes (pre-payment, pay-as-you-go, and post-payment). We suggest that consumer preferences for particular pricing schemes are likely to be determined by systematic relationships that exist among a variety of psychological variables. We offer nine empirical propositions that identify when consumers will prefer different pricing schemes.

Introduction

The online payments[1] sector in e-commerce has been analogized to the Chevrolet in the automobile industry: not terribly exciting, but big and capable of having a huge impact on the market (Burnham, 1999). Some researchers have argued that the success of e-commerce business models depends critically on firms' ability to design and implement secure online payment systems in the marketplace (Aldridge, White & Forcht, 1997; O'Mahony, Peirce & Tewari, 2001). Key payment system considerations include (i) the timing of payment and consumption (that is, manipulating pricing schemes), and (ii) the characteristics of payment systems (for example, system usability, level of feedback consumers receive) (Dutta, Jarvenpaa, & Tomak, 2003). In this chapter we focus on the first feature — the timing of payments and consumption — and attempt to describe the impact that online pricing scheme variations may have on consumers' preferences for payment systems.

In the traditional transaction model, the transfer of ownership of goods from seller to buyer occurs when the buyer provides payment to the seller. At the moment a seller receives payment, the buyer is free to consume his or her purchase. When consumers purchase their goods with cash, the moment of transfer from seller to buyer is relatively easy to pinpoint. In such transactions payment and the freedom to consume one's purchase are simultaneous.

In the modern world, where cash purchases grow less common by the day, consumers often experience a separation between their consumption of their newly acquired goods and their payment for those goods. Most notably, with the advent of magnetic-stripped credit cards around 1970, consumers became accustomed to consuming some routine goods weeks and months before making payment. As online purchase options became available, the consumption-payment separation followed the familiar pattern in which consumption precedes payment. For example, when consumers download a song from a music provider or access a computer document through Wi-Fi connectivity, they may rely on a direct billing mobile payment solution. In such cases, aggregate payments are generally made to the mobile service provider at the end of a monthly billing cycle (for example, T-mobile data services at Starbucks). We refer to pricing schemes in which payment follows consumption as "post-payment."

Sometimes electronic pricing schemes are designed such that payment precedes consumption. For example, consumers who purchase prepaid Internet

scratch cards or Millicent micro-payment systems pay in advance for anticipated future consumption of digital products and services. We refer to pricing schemes in which consumption follows payment as "pre-payment."

Finally, we note that the increased use of electronic payment plans does not always require separation between payment and consumption. Consumers who pay for goods using direct-debiting e-wallets are free to consume their goods at the moment they purchase them. We refer to pricing schemes in which payment and freedom to consume are simultaneous as "pay-as-you-go."

In light of the increasingly common temporal separation between payment and consumption for consumer goods and services that the e-commerce revolution has promoted, it is important to ask how, if at all, such separation matters to consumers. From an economic standpoint, a rational consumer should be unconcerned with the temporal differences across various pricing schemes provided that the revenue streams are "properly" discounted. But, as recent research in behavioral economics documents, the tenets of economic theories of rationality and exponential discounting sometimes run afoul of the realities of consumer choice. The behavioral economics literature has identified descriptive models of economic decision-making by incorporating insights gleaned from decades of behavioral research (Kahneman & Tversky, 1979; Loewenstein, 1987; Simon, 1957). Within the behavioral economics literature, research on "mental accounting" has shown that temporal separation of payment and consumption (that is, pre-payments and post-payments) impacts a consumer's mental perception of a transaction and subsequently affects his or her preference for a given pricing scheme (Thaler, 1999). Specifically, experimental studies show that pre-payment pricing schemes offer greater hedonistic pleasure to consumers than other pricing schemes (Ariely & Silva, 2002; Prelec & Loewenstein, 1998). However the sheer popularity of credit cards and "pay-as-you-go" pricing schemes (for example, direct-debiting micro-payments) apparently run counter to these experimental findings. This chapter reviews the relevant behavioral economics literature and attempts to answer three research questions:

- How do consumers experience transactions when payment and consumption are temporally separated?
- What is the theoretical rationale behind pre-payment pricing schemes?

- What theoretical arguments does the behavioral economics literature offer to explain consumer acceptance of payment systems that are based on post-payment or pay-as-you-go pricing schemes?

In the next section we discuss the relevant literature in behavioral economics that lays the foundation for subsequent theoretical arguments. In the section on transactions we discuss the rationale behind preference for payment systems based on pre-payment pricing schemes. The section on challenges to pre-payment is divided into four subsections. We provide arguments in each subsection from four different theoretical perspectives to explain why consumers may sometimes prefer post-payment or pay-as-you-go pricing schemes. The final section concludes.

Theoretical Foundations for Temporal Influences on Choice

Prospect Theory

To understand individual behavior with respect to payments and consumption, we begin by considering descriptive theories of human decision making. Expected utility theory (EUT) is the most important economic theory of decision making under conditions of uncertainty. According to EUT, a rational decision maker should and will select options that offer the highest expected utility, where expected utility is measured as the utility of individual outcomes multiplied by their respective probabilities of occurring. A version of EUT introduced in the 1950s in which the probabilities are subjective is known as subjective expected utility theory (SEUT). Although EUT and SEUT had some value in predicting decisions, behavioral research demonstrated that both models were incomplete. Prospect theory, introduced by Kahneman and Tversky (1979), proved to be a psychologically richer and more descriptively accurate theory of decision making under uncertainty. Like EUT and SEUT, prospect theory assumes that the value of an option is measured as the summed product of uncertainties and outcomes. However the more psychological prospect theory differs from the economic theories in several important

respects. First, prospect theory replaces the notion of utility and a utility function with "value" and a value function. The value function, which represents the central components of the human pleasure machine, has three important properties. It is defined over perceived gains and losses relative to some natural reference point rather than in terms of absolute values of wealth as in the standard economic theory. The motivating idea behind such a definition of value is that the context within which outcomes are presented plays a key role in determining whether people will perceive those outcomes to be good or bad. A $50 cost may actually be perceived to be a gain by the consumer who was expecting to pay a lot more, whereas a $25 discount may be perceived to be a loss by the consumer who was expecting a larger discount. Thus depending on the point of reference a decision maker employs, each transaction is accorded the status of either a gain or a loss. Second, the value function is concave for gains and convex for losses. This contrasts with the concavity of the standard utility function across all values. The unique shape of the value function corresponds to the idea that there is diminishing sensitivity to both increasingly large gains and increasingly large losses. Hence the difference between a $10 loss and a $20 loss has a larger impact on the consumer than the difference between a $110 loss and a $120 loss. Third, the value function is steeper for losses than for gains. This feature implies that the pleasure incurred from a $100 gain is less than the pain incurred from a $100 loss.

Mental Accounting and Hedonic Editing: Integration and Segregation of Gains & Losses

Prospect theory drives home the point that people do not think about value in purely economic terms. The value of, say, a $100 gift certificate to a shopper may vary depending on various contextual factors. In a similar vein, research shows that people treat some sources of money differently from others. Specifically, people tend to organize their financial world into separate "mental accounts," the contents of which are often treated differently. Although such differential treatment promotes economically indefensible decisions, research shows that mental accounting is pervasive. As such, it should be of great interest to firms as they consider different ways to price their goods and services.

The architect of mental accounting, Richard Thaler, defined mental accounting as a set of cognitive operations used by individuals to organize, evaluate, and keep track of their financial activities (Thaler, 1999). In accordance with prospect theory, people tend to view the contents of their mental accounts in

terms of gains and losses. In recent years, researchers have begun to ask how people can manipulate the gains and losses in their mental accounts so as to experience them in the most hedonistically favorable ways. This research shows that individuals may use four simple hedonic editing principles to make themselves happier: (a) segregate their gains ("gain savoring"), (b) integrate their losses, (c) cancel losses against larger gains ("loss buffering"), and (d) segregate silver linings. The justification for these principles is as follows. When gains are segregated, the feeling of pleasure is enhanced relative to the feeling of pleasure experienced when the gains are aggregated. Thus two $100 discounts are better than a single $200 discount. When losses are integrated, the feeling of pain is reduced relative to the feeling experienced under segregation. Thus a single $200 price increase hurts less than two $100 price increases. When losses are cancelled against larger gains, the feeling of pain from the loss is eliminated behind the larger gain. Finally segregating silver linings highlights the small gains that might otherwise be invisible in the face of a relatively larger loss.

Thaler and Johnson (1990) explored the limits of hedonic editing principles by researching the impact of prior outcomes on current decision choices. They used "temporal spacing" to facilitate cognitive segregation or integration of events. They argued that events are more likely to be integrated if they are temporally contiguous (for example, events that occur on the same day) but more likely to be segregated if they are temporally spaced (for example, events that occur two weeks apart). The authors found evidence that supported the hedonic principles. Linville and Fisher (1991) arrived at similar conclusions with respect to people's preferences for temporally separating and combining "emotionally impactful" events.

Mental accounting research on segregation of gains and integration of losses indicates that hedonic editing principles serve as reasonably good descriptions of how people would like their worlds to be organized (though there is less evidence in support of loss integration). Therefore hedonic editing principles may offer insights regarding how consumers are likely to view transactions in which there is temporal separation between payment and consumption.

Breaking and Combining Experiences

In order to understand how consumers are likely to experience the totality of their purchase experience, it is important to understand the impact of each of the transient states that comprise the purchase experience. If we assume that

consumption and purchase are two states that consumers experience, each with their own hedonic features, a key question for our chapter is whether and how separation of payment and consumption affects the consumer's experience. For insight, we turn to the recent literature on how people experience different outcome sequences in intemporal choice tasks.

The literature on how people evaluate and experience single outcomes vs. sequences of outcomes is now extensive (Ariely & Carmon, 2000; Loewenstein & Prelec, 1991, 1993). An important question that this stream of research seeks answer to is whether or not people integrate the transient states that they experience as events unfold. Though there are exceptions (for example, Ariely & Zauberman, 2000), most of the literature suggests that people do integrate their experiences as events unfold. When a person watching a play is asked to rate her enjoyment of the play at fixed intervals, her numerical answers provide a "hedonic profile" of her overall experience. Research examining the relationship between hedonic profiles and overall evaluations of experiences demonstrates that the pattern of such hedonic profiles impacts overall evaluations.

Loewenstein and Prelec (1991, 1993) found that people summarize their overall experiences more positively when the sequence of events shows an improving trend. Ariely (1998) also reported that trend was a positive predictor of overall experience. In an experiment that measured pain levels, he shows that a sequence of aversive stimuli that increases in intensity over time is rated to be more painful than sequences that either do not change or that decrease in intensity. Other research has identified the "velocity," or rate at which hedonic profiles change, to be an important determinant of overall experiences (Hsee & Abelson, 1991; Hsee, Abelson & Salovey, 1991).

Ross and Simonson (1991) studied the chronological ordering of events and theorized that people prefer experiences that have "happy endings." They showed that an experience consisting of both a negative and a positive event is evaluated as more satisfactory if the positive event occurs last. Varey and Kahneman (1992) showed that extended aversive episodes are not evaluated simply by integrating disutility of successive intervals. Instead final moments and trend quality (improving or deteriorating) are more important predictors. Other studies also found that key points in time, such as the most intense moments and the final moments (that is, peak and end) of an experience, accounted for global retrospective evaluations of experiences (Frederickson & Kahneman, 1993; Redelmeier & Kahneman, 1996).

However not all events comprising an experience are automatically integrated before the experience is evaluated. Ariely and Zauberman (2000) theorized

that the relationship between experiences and their overall evaluations will differ depending on whether the experiences are perceived to be composed of single or multiple components. Their results showed that breaking up of experiences substantially reduces the impact of hedonic profile on overall evaluations. When there are multiple experiences that are temporally separated from one another, each isolated experience (rather than the overall hedonic profile) may provide a basis for judgment (Ariely & Zauberman, 2000).

The discussion above should be of interest to firms that are concerned about how consumers are likely to feel about the purchase experience. Whether consumers experience a purchase as a loss or a gain may depend on whether or not they integrate the transient states of paying and consuming, as well as the order in which those events occur. Consider, for example, the consumer who prepays for digital content (such as a stock report) online vs. one who pays for the identical content weeks after consuming the report. Will one of these consumers report having a more positive overall purchasing experience? Will these consumers evaluate the constitute parts (consumption and payment) differently? If the answer to either question is yes, then firms should be aware that the payment technology they choose may affect customer satisfaction as well as the chance of repeat business.

Transactions: Payments and Consumption

Payment and consumption are two central components in every consumer purchase. How do consumers experience these components? The answer may depend on the nature of the mental accounts that consumers employ for their purchases. At least three types of mental accounts have been discussed in the literature: separate accounts, single-entry accounts, and double-entry accounts. We discuss each type of account below.

Consumers Maintain Separate Mental Accounts

According to this view, individuals experience payments and consumption as discrete events and evaluate them separately as losses or as gains (Hirst, Joyce & Schadewald, 1994). Thus people experience a feeling of gain when they

consume and a feeling of loss when they make a payment. These feelings occur at different times and are independent of one another. Thus pricing schemes are evaluated as combinations of discrete events, where one group of events is identified as gains (consumption benefits) while the other group is identified as losses (payments).

However the suggestion that payment and consumption are isolated gains or losses may not be generally applicable. Payment and consumption are ordinarily linked to one another even when they are temporally separated (Thaler, 1999). Moreover the construal of payments as losses may not always be hedonistically inefficient since people are found to be more sensitive toward losses than they are towards gains (see the previous section on prospect theory; Kahneman & Tversky, 1979). The following example, adapted from Thaler (1999), illustrates this point. Imagine a thirsty consumer who values a can of soda at $1 is standing in front of a vending machine that sells soda for $0.75. Although the consumer should make the purchase under these conditions, one who frames payments as losses should reject the purchase. Thus, under this interpretation, almost every transaction becomes hedonistically painful to the consumer unless utility derived from consumption is considerably more than the disutility of payment.

Consumers Maintain Single-Entry Mental Accounts

This viewpoint postulates that individuals establish mental accounts that create symbolic linkages between specific acts of consumption and specific payments. Individuals combine payment and consumption events together within a mental account and evaluate the transaction only when the account is closed (Thaler, 1999). When payment and consumption are temporally separated, closure depends on which event is later. In pre-payment pricing schemes, closure takes place with the last consumption, while in post-payment pricing schemes closure takes place with last payment. A payment, by itself, is not deemed a loss, and consumption, by itself, is not deemed a gain. However, for pre-payment pricing schemes, if consumption does not take place or if the consumption is not commensurate to the payment made, then the individual might retrospectively evaluate the payment as a loss. On the other hand, consumption might be evaluated retrospectively as a gain if the mental account is closed without a commensurate payment made against that consumption. But, in general, it is assumed that in a normal transaction, payment and consumption are commen-

surate to one another though they may take place at different times. Thus if an individual maintains a mental account for a given transaction and only evaluates the account at the time of closing, it should not matter to him or her whether he or she is paying earlier, later, or as he or she is consuming (assuming revenue streams are discounted).

However the assumption that consumers maintain single-entry mental accounts may not explain the actual feelings of loss or gain that consumers experience in transactions where payment and consumption occur at different times. When people make payments, they often *do* experience an immediate pain of loss (Prelec & Loewenstein, 1998). For example, imagine paying for a vacation six months after you have enjoyed it. Though the amount you are paying is commensurate to the enjoyment you derived during the vacation, the pain associated with payment may be the only immediate sensation. In fact, your enjoyment during the vacation itself may have been reduced by thoughts of the impending payments. In contrast, a prepaid vacation may be more enjoyable because it is un-marred by thoughts of future payment.[2] A consumer who maintains a single-entry mental account for the vacation transaction will not perceive any difference between the two situations.

Consumers Maintain Double-Entry Mental Accounts

According to the third view, individuals mentally combine payment and consumption within a single mental account *but evaluate the account every time they pay or consume*. Thus an individual feels a net pain or pleasure at the moment of consumption or payment depending on whether the mental account is in the red or the black at that particular moment (Prelec & Loewenstein, 1998). Prelec and Loewenstein (1998) propose that the effects of the time distance from payment depend on whether the payments are made before or after consumption. Based on anticipation and dread (Loewenstein, 1987), they argue that paying after a consumption experience is hedonistically inferior to paying before consumption. Most of these arguments build on the previous research, which showed that people generally prefer to experience improving trends and happy endings (see the previous section; Kahneman, Frederickson, Schereiber & Redelmeier, 1993; Loewenstein & Prelec, 1991, 1993; Ross & Simonson, 1991).

Prelec and Loewenstein (1998) formulate a double-entry mental accounting theory that describes the reciprocal interactions between the pleasure of

consumption and the pain of paying. According to this model when payment and consumption are temporally separated, a consumer's pleasure from consumption is undermined by an imputed cost of making a payment, and his or her pain from payment is buffered by an imputed benefit derived from that payment. An *imputed cost* of payment is a disutility that reduces the pleasure of consumption by introducing negative thoughts of payment associated with that consumption. An *imputed benefit* of consumption is a utility that buffers the pain of paying by introducing positive thoughts of consumption. Thus the utility from consumption experience is equal to the utility from consumption less the imputed costs of payment. The disutility from payment experience is equal to the disutility from payment less the imputed benefits of consumption. The consumer's net utility in the transaction mental account is the summation of the net utility from the payment account and the net utility from the consumption account.

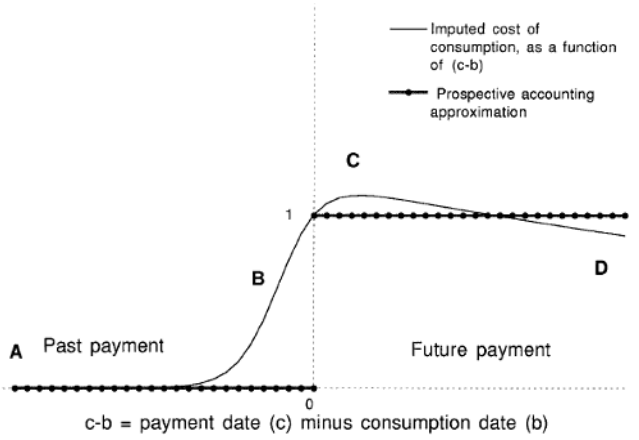
Pricing Implications of the Double-Entry Mental Account: Firms Should Offer Pre-Payment Technologies

Among the three alternatives discussed above, the double-entry mental accounting method emerges as the most theoretically plausible and empirically validated description of how consumers process their payment and consumption experiences. That is, payments and consumption are most likely integrated and evaluated during each payment and consumption event. Double-entry mental accounting overcomes the weaknesses of both separate and single-entry mental accounts.

Double-entry mental accounting predicts that consumers will prefer pre-payment pricing schemes over post-payment or pay-as-you-go pricing schemes. The rationale for the superiority of pre-payment pricing scheme comes from the assumption of "prospective accounting." In prospective accounting, expected utility or disutility from future payment and consumption is given more weight than utility or disutility from past experiences of payment and consumption. The assumption theoretically agrees with the empirical work of Gourville and Soman (1998), who found prepaid sunk costs (like pre-payments) to fully depreciate with passage of time. We show a pictorial representation of the prospective accounting assumption in Figure 1 (adapted from Prelec & Loewenstein, 1998).

Under prospective accounting assumption of double-entry mental accounting, the experience of consumption and payment is enhanced by pre-payment.

Figure 1. Prospective accounting: Dependence of imputed cost of consumption on the time of payment



Adapted from Prelec and Loewenstein (1998)

Imagine the context of paying for and enjoying a vacation, an example that we mentioned while discussing single-entry mental accounting. If the vacation is paid for a long time in advance (point A), then the imputed cost of enjoying the vacation is essentially zero and the vacation feels almost free. If the vacation is recently prepaid (point B), then imputed cost is not negligible but still relatively small due to payment depreciation (see Gourville & Soman, 1998). Imputed costs are highest if the payment needs to be made right after consumption (point C) and then the costs gradually decrease as payment is pushed to the future (point D). Based on the assumption of prospective accounting, double-entry mental accounting predicts strong debt aversion. They show that for most feasible ranges of discount factors, consumers find it less painful to prepay than to pay later. Consumers are found to prefer pre-payment pricing schemes even if it involves paying more for the same usage. This result is further strengthened by a recent experimental study (Ariely & Silva, 2002) where the authors asked the subjects to choose between various payment systems that were differentiated with respect to timing of payments and consumption. The findings revealed that the subjects strongly preferred pre-payment pricing schemes like subscription mechanisms over other payment systems based on non pre-payment pricing schemes. Accordingly, firms should also offer pre-payment technologies, as they are more acceptable to consumers.

Theoretical Challenges to the Pre-Payment Option

Despite the theoretical rationale and empirical findings that appear to favor the use of pre-payment pricing plans (Ariely & Silva, 2002; Prelec & Loewenstein, 1998), post-payment and pay-as-you-go pricing schemes are popular. Credit cards are an obvious example (Prelec & Simester, 2001). Is the popularity of the post-payment credit card plan due to failure of firms to come to grips with the factors that drive the consumer, or might it be that consumer preference for pre-payment schemes is not as strong as Prelec and Loewenstein (1998) suggested?

Hedonic Efficiency vs. Decision Efficiency

The literature indicates that consumers adopt either a hedonic efficiency perspective or a decision efficiency perspective while evaluating a transaction experience. Hedonic efficiency perspective is based on the assumption that consumers love pleasure, and hence they should prefer whatever pricing scheme gives them the least pain and/or most pleasure. On the other hand, according to decision efficiency perspective, consumers have objectives beyond the current transaction, and hence they might prefer choosing pricing schemes that will benefit them in the long run even though the pricing scheme is less hedonistic in the short term.

Take the case of a payment system that keeps a consumer aware of what he or she is spending but makes him or her go through a more painful (and more memorable) payment process (Dutta et al., 2003; Soman, 2001). Though this payment system is efficient from a decision efficiency perspective, it is hedonistically inefficient because it is more painful. The consumer keeps better control of her finances if she is more aware of her spending. However increased awareness comes mainly from increased salience of the payment process, which, in turn, makes the act of making a payment more painful to the consumer.

Thus, there are obvious trade-offs between the two perspectives. Past research has indicated that people are more inclined to adopt a hedonic efficiency perspective than a decision efficiency perspective (Ariely & Silva, 2002). Double-entry mental accounting that predicts the superiority of pre-payment pricing schemes is based on a hedonic efficiency perspective. However there

Table 1. Alternative theoretical arguments

Theoretical Basis	Proposition	Preference Relation	Supporting Literature
Hedonic Efficiency Perspective			
– Payment System Properties	1: Consumer preference for pre-payment pricing schemes is not independent of payment system properties, and may not hold for certain payment systems.	Depends on context	Prelec and Loewenstein, 1998
– Aggregated Payments	2: Payment systems based on post-payment pricing schemes that include aggregated payments may not be hedonistically inferior to payment systems based on pre-payment pricing schemes.		Kahneman and Tversky, 1979; Thaler, 1985, Redelmeier and Tversky, 1992; Prelec and Loewenstein, 1998; Thaler, 1999
– Past Experience	3: If consumers experience remembered utility or remembered disutility, and if these utilities have measurable imputed costs and/or benefits, then consumers' preferences for pre-payment vs. post-payment pricing schemes will vary across contexts.	Depends on context	Kahneman, Wakker, and Sarin, 1997; Read and Loewenstein, 1999; Kahneman and Snell, 1992; Prelec and Loewenstein, 1998
– Narrow Bracketing	4: If consumers use a narrow time bracket to compare pricing schemes, and if consumption and/or payments is not completed within that time bracket, then consumers may consider post-payment pricing schemes to be hedonistically superior to pre-payment pricing schemes.	Depends on context	Benartzi and Thaler, 1995; Camerer, Babcock, Loewenstein and Thaler, 1997; Thaler, Tversky, Kahneman, and Schwartz, 1997
Decision Efficiency Perspective			
– Effect of Sunk Cost	5: If there is payment depreciation when payments precede consumption, and if payment depreciation is cognitively driven, then consumers may prefer post-payment or pay-as-you-go pricing schemes over pre-payment pricing schemes.	Post-Payment $\succ$ Pre-payment Pay-as-you-go $\succ$ Pre-payment	Thaler, 1980; Heath, 1995; Gourville and Soman, 1998; Soman and Gourville, 2001
– Impulse Products and Self-Control	6: Consumers may prefer pay-as-you-go pricing schemes over pre-payment or post-payment pricing schemes when they use payment systems as external devices to control their impulsive behavior.	Pay-as-you-go $\succ$ Pre-payment & Post-payment	Hoch and Loewenstein, 1991; Wertenbroch, 1998; Ariely and Wertenbroch, 2002; Ariely and Silva, 2002
Time Inconsistent Behavior			
– Immediacy Effect	7: Consumers may prefer post-payment pricing schemes over pre-payment pricing schemes if they are disproportionately attracted toward immediate consumption or disproportionately repulsed by immediate payment.	Post-payment $\succ$ Pre-payment	Phelps and Pollak, 1968; Ainslie, 1975; Christensen-Szalanski, 1984; Loewenstein, 1992
Future Utility			
– Projection Bias	8: Consumers who are aware of their projection biases may prefer pay-as-you-go pricing schemes over pre-payment or post-payment pricing schemes.	Pay-as-you-go $\succ$ Pre-payment & Post-payment	Loewenstein, O'Donoghue, and Rabin, 2002
– Uncertainty	9: Consumers who are uncertain about the utility of future consumptions may prefer post-payment or pay-as-you-go pricing schemes over pre-payment pricing schemes.	Post-payment $\succ$ Pre-payment Pay-as-you-go $\succ$ Pre-payment	Mischel and Grusec, 1967; Thaler, 1981; Loewenstein, 1987; Lovallo and Kahneman, 2000

is ample evidence that individuals also make decisions based on decision efficiency (Heath, 1995). Hence a decision efficiency perspective provides an obvious counter-argument to the presumed superiority of pre-payment pricing schemes.

In the following sections, we explore relevant portions of the behavioral economics literature to identify theoretical rationales that may explain consum-

ers' frequent preference for post-payment or pay-as-you-go pricing schemes (see Table 1 for a summary). We conclude each section with a summary proposition, some of which have two parts. We offer nine propositions in all.

Explanations Using Hedonic Efficiency Perspective

In this sub-section, we explain why, from a hedonic efficiency perspective, consumers may not typically prepay when given a choice among pricing plans.

Payment System Properties

A pricing scheme is concerned with when the firm charges its customers to generate revenue (that is, before, after or during consumption) while a payment system, among other things, deals with how that pricing scheme is implemented in practice. Payment system properties like convenience, acceptability, and so forth, may be important determinants for consumer preference for payment systems. For example, the primary reason credit cards are a popular way to conduct transactions may be simply due to the convenience, accessibility, and acceptability they offer to the consumers. When we assume that consumers maintain double-entry mental accounts of transactions, both pricing scheme and payment system properties are responsible for moderating the pain and pleasure that consumers experience while using the payment system.

The arguments for the above contention are built into double-entry mental accounting. Prelec and Loewenstein (1998) modeled imputed costs and imputed benefits through two coupling coefficients, which captured the extent of conversion of *payments into imputed costs* and *consumption into imputed benefits*. These coefficients are termed *attenuation* (the degree to which payments attenuate pleasure of consumption) and *buffering* (the degree to which consumption buffers pain of payment). Properties of the payment system used to implement the pricing scheme may well determine the level of coupling experienced by a given consumer. Table 2 gives examples that show how coupling parameters might vary with different payment systems and pricing schemes. In other words, for a given individual, the level of imputed costs and imputed benefits experienced may vary from one payment system to another even though the pricing scheme remains the same.

Consider the following example. Charge cards and credit cards are two payment systems, both based on post-payment pricing schemes. However the

Table 2. Pricing schemes and payment systems

		Payment Systems		
		Determines, among other things, how pricing schemes are implemented in practice		
		Examples of currently used payment system	Coupling parameters	Examples of new electronic payment systems
Pricing Schemes Concerned with when the firm decides to charge its consumers for consumption	Pre-payment schemes	Subscription with no payment confirmation	Attenuation: Low Buffering: Low	Stored value cards, Dual slot mobile payment solutions, Micro-payment solutions like Millicent, Subscrip, Micromint
		Subscription with payment confirmation	Attenuation: High Buffering: Low	
	Pay-as-you-go schemes	Cash, Checks, Debit cards	Attenuation: High Buffering: High	Direct-debiting e-wallets, Micro-payment solutions like NewGenpay systems
	Post-payment schemes	Credit cards	Attenuation: Low Buffering: Low	Mobile direct billing solutions, Payword
		Charge cards	Attenuation: Low Buffering: High	

two payment systems differ in that the consumer pays the entire payment due at the end of the billing cycle for charge cards, while he or she only pays the minimum payment due at the end of a billing cycle for credit cards.[3] Thus charge cards have low imputed costs since a single bill covers many distinct items, none of which is individually responsible for the total. However charge cards have high imputed benefits — since one payment is associated with all consumption, the consumer can relate all benefits to just one payment. Credit cards, on the other hand, have low imputed costs, since a single bill covers many items and low imputed benefits, since no single payment is associated with all the consumption in that billing cycle (not true if the consumer pays the entire amount due at the end of every billing cycle).

Naturally pricing schemes themselves impact coupling parameters. But payment systems used to implement those pricing schemes may change the preference relationships between pricing schemes by moderating imputed costs and/or imputed benefits experienced by consumers. For example, for charge cards, a consumer experiences low imputed costs and high imputed benefits. Now if there is a payment system based on a pre-payment pricing scheme that has low imputed costs and low imputed benefits, a consumer might evaluate charge cards to be more hedonic even though they are based on a post-payment pricing scheme. This is because the hedonic advantage of using a pre-payment scheme might be nullified by the greater imputed benefits that a consumer enjoys when using a charge card.

Proposition 1: Consumer preference for pre-payment pricing schemes is not independent of payment system properties, and may not hold for certain payment systems.

Aggregated Payments

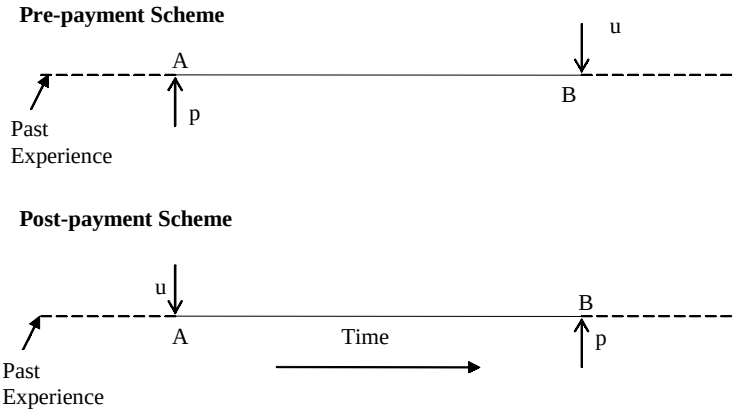
Both Prelec and Loewenstein (1998) and Thaler (1999) have suggested that *aggregated payments* are the main reason for the popularity of payment systems like credit cards or charge cards among consumers. When using payment systems like credit cards or charge cards, consumers do not need to make payments for each and every consumption; payments are generally aggregated at the end of a billing cycle. Past literature has suggested that aggregated evaluation of prospects is hedonistically more efficient (Redelmeier & Tversky, 1992). For example, compare the impact of paying $50 cash to the impact of adding another $50 to a $940 monthly bill. Thaler (1999) posits that the $50 cash will appear much larger by itself than in the context of a much larger bill that contains many other similar items. Lack of one-to-one correspondence between payment and consumption makes each consumption benefit appear less costly to the consumer. The correspondence between payment and consumption becomes even weaker when consumers only need to pay the minimum amounts due at the end of every billing cycle. Thus, when payments are aggregated, consumers suffer less pain. In this manner, post-payment pricing schemes may be hedonistically more preferable.

Proposition 2: Payment systems based on post-payment pricing schemes that include aggregated payments may not be hedonistically inferior to payment systems based on pre-payment pricing schemes.

Past Experience

If consumers experience the hedonic utilities from memories of past experiences, then double-entry mental accounting may not result in superiority of pre-payment pricing schemes. For example, "prospective accounting" (Prelec and Loewenstein, 1998), assumption of double-entry mental accounting, ignores the hedonic impact of past events. Such events are assumed to have zero utility or disutility (Figure 1). Thus a consumption already paid for is enjoyed as if it were free, and payments made later are not buffered by thoughts of experi-

Figure 2. Past experience and pricing schemes



enced past utilities. However there is evidence that memories of past experiences — so-called "remembered utilities" — do have a hedonic impact on consumers (Kahneman & Snell, 1992; Kahneman, Wakker & Sarin, 1997; Read & Loewenstein, 1999). For example, paying later for an enjoyable vacation surely gives less pain than paying later for a terrible vacation. Happy memories probably reduce the pain of payment whereas unhappy memories probably compound the payment pain.

In the next few paragraphs, we show how remembered utilities can play a role in determining whether consumers would prefer pre-payment or post-payment pricing schemes. We provide a two-period model with pricing schemes in Figure 2. In the pre-payment pricing scheme the consumer pays *p* in period A and enjoys benefits from consumption *u* at period B. The situation is reversed in the post-payment pricing scheme: The consumer enjoys benefits from consumption *u* at period A and pays *p* for that consumption at period B. Both utilities from consumption and disutilities from payments are discounted in the second period using a discount factor δ. To explain the relevance of past experiences, we calculate net utility from the two pricing schemes as in Prelec and Loewenstein (1998).

Pre-payment Pricing Scheme: If there is a hedonic impact from both future expectations and past memories at point A (Figure 2), the following things should occur:

(i) individuals feel pain due to the disutility of making the payment (p),

(ii) individuals feel pleasure due to the imputed benefits of payment (*Imputed Benefit*, IB),

(iii) individuals feel pleasure or pain depending on whether they had positive or negative memories of similar consumption experiences (*Remembered Utility of Past Experience*, RUPE).

While consuming at point B (Figure 2), the following things should occur:

(i) individuals feel pleasure due to the utility from consumption (u),

(ii) individuals feel pain due to the memories of payment made earlier (*Remembered Cost of Payment*, RCP).

Thus the net utility from the pre-payment scheme to the consumer is:

$$(- p + IB +/- RUPE) + \delta (u - RCP) \text{ i.e. } (-p + \delta u) + (IB +/- RUPE - \delta RCP) \quad (1)$$

If past utilities and disutilities are ignored, then the net utility from pre-payment scheme reduces to:

$$(-p + \delta u) + IB \quad (2)$$

Post-payment Pricing Scheme: At point A (Figure 2), the following things should occur:

(i) individuals feel pleasure due to the utility from consumption (u),

(ii) individuals feel pain due to imputed cost of consumption (*Imputed costs*, IC),

(iii) individuals feel pleasure or pain depending on whether they had positive or negative memories of similar consumption experiences (*Remembered Utility of Past Experience*, RUPE).

At point B (Figure 2), the following things should occur:

(i) individuals feel pain due to the disutility of making a payment (p),
(ii) individuals feel pleasure due to the memories of consumption experienced earlier (*Remembered Utility of Consumption*, RUC).

Thus the net utility from post-payment scheme to the consumer is:

$$(u - IC +/- RUPE) + \delta (-p + RUC) \text{ i.e. } (-\delta p + u) + (-IC +/- RUPE + \delta RUC) \quad (3)$$

If past utilities and disutilities are ignored, then net utility from post-payment scheme reduces to:

$$(-\delta p + u) - IC \quad (4)$$

The implication of this model is that when past utilities and disutilities are ignored, and when there is no time discounting, pre-payment is always preferable to post-payment. This can be seen by noting that IB is added in [2] and IC is subtracted from the same amount in (4) (given there is no time discounting). Even when there is time discounting, pre-payment is preferable except when $\delta << 1$ (signifying high impatience) and/or coupling coefficients are low. This is what double-entry mental accounting predicts when there is prospective accounting (Prelec & Loewenstein, 1998). *However*, when there is some hedonic utility from past experiences, preference for pre-payment pricing schemes depends on whether:

$$(IB +/- RUPE - \delta RCP) > (-IC +/- RUPE + \delta RUC) \Rightarrow$$
$$(IB - \delta RCP) > (-IC + \delta RUC).$$

Even when δ is assumed to be 1 (no discounting), the superiority of one scheme over another depends on the relation between Imputed Benefits, Imputed Costs, Remembered Utility of Consumption, and Remembered Cost of Pay-

ment. Because relations among these features vary from one experience to another, it is not possible to offer simple predictions about consumer preferences for pricing schemes. For example, if *Remembered Utility of Consumption* is greater than Imputed Costs and *Remembered Cost of Payment* is greater than Imputed Benefits, then consumers may prefer post-payment pricing schemes over pre-payment pricing schemes. However, if *Remembered Utility of Consumption* is less than Imputed Costs, and *Remembered Cost of Payment* is less than Imputed Benefits, then consumers will prefer pre-payment pricing schemes over post-payment pricing schemes.

Proposition 3: If consumers experience remembered utility or remembered disutility, and if these utilities have measurable imputed costs and/or benefits, then consumers' preferences for pre-payment versus post-payment pricing schemes will vary across contexts.

Narrow Bracketing

Psychological principles that govern the perception of decision problems and evaluation of outcomes can produce predictable shifts in preferences when the same problem is "framed" in different ways (Tversky & Kahneman, 1974). As Read, Loewenstein, and Rabin (1999) note, when an individual makes a choice, he or she may assess the consequences of all the choices taken together (broad brackets) or may assess each choice in isolation (narrow brackets). Empirical research has shown that people often exhibit narrow bracketing behavior (Benartzi & Thaler, 1995; Camerer, Babcock, Loewenstein & Thaler, 1997; Thaler, Tversky, Kahneman & Schwartz, 1997). For example, individuals use narrow time brackets to evaluate their mental accounts, that is, they evaluate their mental accounts too frequently. When individuals use narrow time brackets, they may land up making suboptimal choices from both hedonic and decision efficiency perspectives. For example, Camerer et al. (1997) observed that New York City cabdrivers exhibit narrow bracketing behavior by evaluating and closing income accounts every day against a daily target. Such behavior is suboptimal because it required cabdrivers to stop working early on good (that is, busy) days and to work late on bad days. Had the cabdrivers used broader weekly or monthly targets to evaluate their income accounts rather than daily targets, they would have earned as much or more by

working much less. The cabdrivers could have accomplished this feat by working fewer hours on bad days when the per-hour income rate was low, but more on good days when per-hour income rate was high.

The reasons for narrow bracketing have been variously attributed to limited cognitive capacity (Baddeley, 1986; Kahneman, 1973; Miller, 1956; Simon, 1957), cognitive inertia (Kahneman & Knetsch, 1992; Redelmeier & Tversky, 1992), preexisting heuristics (Read, Loewenstein & Rabin, 1999), and self-control shortcomings (Ainslie & Haslam, 1992). Whatever the cause, we suggest that the way consumers bracket alternatives may affect their preference among pricing schemes. Prelec and Loewenstein (1998) assumed that people evaluate a pricing scheme whenever payment or consumption takes place but close the account only when all consumption and payments for a given transaction are over. However, when comparing pricing schemes, individuals may choose to use a narrow time bracket and take into account only what is immediate instead of considering the entire time span of the pricing schemes. For example, while comparing two pricing schemes, a consumer may compare current disutility of payment from pre-payment schemes to current utility of consumption from post-payment schemes. The hedonic consequences of future utility from consumption in pre-payment schemes or future disutility of payment in post-payment schemes may fall outside the narrow time frame bracket used by the consumer to compare the two schemes. Thus when a narrow bracket is used, the consumer may prefer post-payment to pre-payment even though pre-payment is hedonistically superior in the overall context.

Proposition 4: If consumers use a narrow time bracket to compare pricing schemes, and if consumption and/or payment is not completed within that time bracket, then consumers may consider post-payment pricing schemes to be hedonistically superior to pre-payment pricing schemes.

Explanations from a Decision Efficiency Perspective

In this sub-section we put forward some alternate arguments based on the decision efficiency perspective.

Effect of Sunk Cost

Standard economic theory teaches that good decisions occur when people weigh future costs against future benefits and choose the actions where benefits outweigh cost (Frank, 1991). Past costs and benefits are irrelevant to current decisions as they are "sunk". Research on behavioral decision-making has indicated that people commonly do not ignore "sunk" costs. Instead people respond to sunk costs by escalating their investments (Arkes & Blumer, 1985; Brockner & Rubin, 1985; Staw, 1976; Thaler, 1980).

With regards to temporal separation of payment and consumption, Heath and Fennema (1996) posit that decisions are easier when people are able to align the timing of benefits and costs. When physical alignment is not possible, people mentally align benefits and costs by spreading fixed expenses over time and use. Such mental alignment makes consumers less likely to experience an expense as a loss because the pains of payments are offset by the pleasures of daily use. Thus, when sunk cost effects persist, people tend to spread a prepaid fixed cost across uses to drive the average price below a reference price.

But what happens when the sunk costs themselves are depreciated over time? If sunk costs are depreciated over time, then fewer uses are needed to bring the costs below the reference price. This may lead to under-consumption of pending benefits (Gourville & Soman, 1998; Heath, 1995). Gourville and Soman (1998) theorized that consumers adapt to historic costs over time and that this reduces the effects of sunk costs on consumption of any pending benefit that cannot be inventoried. Now, due to an increased likelihood of foregoing a future benefit because of payment depreciation (reduction of sunk cost effect over time), a consumer might prefer post-payment or pay-as-you-go pricing over pre-payment pricing. The logic is as follows: Because prepaid costs will be depreciated after some time, consumers fear that they would eventually consume less and therefore might not get their money's worth if they pay in advance. That is, consumers fear that prepaid accounts might close prior to the point at which consumers have experienced enough consumption to justify the early payment. Thus consumers concerned about decision efficiency may prefer post-payment or pay-as-you-go pricing schemes if they know that sunk cost effects would depreciate over time.

Soman and Gourville (2001) examined the reasons behind decreased attention to sunk costs when payments precede consumption. The authors proposed that decreased attention to sunk costs may be either cognitively driven (because it is difficult to allocate a single pre-payment across multiple benefits) or motiva-

tionally driven (because people have underlying desires to avoid consumption). Soman and Gourville (2001) found significant effects for both types of arguments but reported stronger effects for "motivationally driven" arguments. If the reasons behind decreased attention to sunk costs are cognitively driven, then the consumer experiences less decision efficiency in a pre-payment pricing scheme. Consequently consumers would not prefer pre-payment pricing schemes because they will be afraid of losing track of their pre-payments and ultimately consuming less than what they purchased.

Proposition 5: If there is payment depreciation when payments precede consumption, and if payment depreciation is cognitively driven, then consumers may prefer post-payment or pay-as-you-go pricing schemes over pre-payment pricing schemes.

Impulse Products and Self-Control

Another argument derived from the decision efficiency perspective draws from the literature on self-control (Hoch & Loewenstein, 1991; Thaler & Shefrin, 1981; Wertenbroch, 1998). Research in this area has shown that consumers may voluntarily and strategically ration purchase quantities of goods that are likely to be consumed on impulse. For example, many smokers buy cigarettes by the pack even though they can afford to buy 10-pack cartons that offer sizable per-unit savings. Thus, by rationing purchase quantities, these consumers self-impose additional transaction costs on marginal consumption, thereby making excessive smoking difficult and costly (Wertenbroch, 1998). Purchase decisions about impulse products are often guided by time-inconsistent preferences that occur due to sudden increases in desire brought on by shifts in the consumer's reference point (Hoch & Loewenstein, 1991). These shifts may occur due to physical or temporal proximity of the consumption item (Kahneman, Knetsch & Thaler, 1991; Loewenstein, 1988; Mischel, 1974; Mischel & Grusec, 1967).People who have experienced time-inconsistency and its consequences (like regret) are likely to develop self-control strategies for imposing consistency on their behavior (Hoch & Loewenstein, 1991).

One way to overcome desire is through will-power tactics such as buying in limited quantities. Ariely and Wertenbroch (2002) have shown that individuals sometimes use external devices to control their impulsive behaviors. Payment systems may be thought of as such an external device (Ariely & Silva, 2002).

By payment systems we mean the method or process used to make a payment (for example, credit card, check, and so forth) As a self-control tactic, people may prefer payment systems that have highly salient payment processes because there is more pain of paying associated with consumption when using these payment systems. In other words if people want to control their own behavior, then they may prefer payment systems where consumption is closely coupled with payments precisely because such coupling is more painful. Thus a consumer might opt for a more salient and cumbersome payment system (for example, a series of small, separate payments) in order to make transactions visible and help lower his or her consumption (Ariely & Silva, 2002). An individual using such a payment system believes that every time he or she decides to indulge in an impulsive purchase, the salient pain of making the payment will help him or her control her future impulses.

A payment system based on a pay-as-you-go pricing scheme is an example of such a payment system. In such systems the close linkage of consumption and payment, in combination with the frequent payments, make it difficult for people to overlook payment pain.

Proposition 6: Consumers may prefer pay-as-you-go pricing schemes over pre-payment or post-payment pricing schemes when they use payment systems as external devices to control their impulsive behavior.

Explanations Using Time Inconsistent Behavior

Contrary to standard economic assumptions, people have been found to exhibit time-inconsistent preferences (Benzion, Rapoport & Yagil, 1989; Loewenstein & Prelec, 1992; Thaler, 1981). That is, people sometimes reverse their preferences based on when they make their decisions. In this subsection we look at how time-inconsistent behavior may explain preferences for payment systems based on non pre-payment pricing schemes.

Immediacy Effect

The "immediacy effect" is a time-inconsistent behavior. This effect may be defined as the tendency of people to give far greater weight to current consumption than to a consumption delayed for any length of time. This effect

explains the phenomenon wherein consumption items that are immediately available exert a disproportionate pull on consumers (Loewenstein, 1992). The standard exponential discounting function that is used to calculate future utility or disutility does not capture the impact of immediacy effect (Frederick, Loewenstein & O'Donoghue, 2002; Prelec & Loewenstein, 1997), and there is substantial evidence that the phenomenon occurs (Ainslie, 1975; Christensen-Szalanski, 1984; Phelps & Pollak, 1968).

The immediacy effect may play a role with respect to consumers' preference for pricing schemes. When a consumer evaluates a pre-payment pricing scheme, she might assign greater weight to the current payment and less weight to the consumption events that are in the future. When this occurs, the current costs of future consumption might appear disproportionately larger than the future benefits from consumption. Alternatively, when the consumer evaluates a post- payment scheme, the benefits from consumption might appear disproportionately large relative to the future costs of consumption (because the benefits from consumption are immediate while the costs are not). Thus, when the lure of immediacy presents itself, the consumer may prefer post-payment pricing schemes over pre-payment pricing schemes.

Proposition 7: Consumers may prefer post-payment pricing schemes over pre-payment pricing schemes if they are disproportionately attracted toward immediate consumption or disproportionately repulsed by immediate payment.

Explanations Using Future Utility

Projection Bias

Preference for pricing schemes may also depend on how future utilities or disutilities are predicted. Though tastes change over time, people tend to exaggerate the degrees to which their future tastes will resemble their current tastes. Loewenstein, O'Donoghue and Rabin (2002) described this behavior as *projection bias*. This bias exists when a person's behavior violates economic rules of intertemporal utility maximization. For example, smoking has deleterious effects on the future well-being of a person. But, in the short term, smoking gives pleasure. Projection bias leads the smoker to under-appreciate

the ill effects and over-consume relative to what would have maximized his or her true intertemporal utility function.

Projection bias has implications for choice of pricing schemes. For post-payment schemes, payment is a future disutility, while for pre-payment pricing schemes, consumption is a future utility. If the consumer is unaware of projection bias, then he or she will expect his or her future utility/disutility from consumption or payment to be similar to his or her current utility/disutility from consumption or payment. Hence, his or her preference for a given pricing scheme should not be affected by projection bias. However, if he or she is aware that his or her tastes might change in future, he or she would be more careful about committing to a pre-payment or a post-payment pricing scheme. He or she knows that in a pre-payment pricing scheme, he or she would make pre-payments expecting a certain level of utility from consumption in future. But at the same time he or she knows that if his or her tastes change, then he or she might obtain considerably less utility than what he or she will be prepaying for. On the other hand, for a post-payment pricing scheme, he or she will fear that his or her expected level of future disutility from payment might be less than what he or she will actually experience in future. Thus, if the person is aware of his or her inability to predict future utility or disutility, then he or she would prefer a pay-as-you-go pricing scheme over either a pre-payment or post-payment pricing scheme.

Proposition 8: Consumers who are aware of their projection biases may prefer pay-as-you-go pricing schemes over pre-payment or post-payment pricing schemes.

Uncertainty

Choice of a pricing scheme might also depend on whether future utility/disutility is certain or uncertain. Prior research has shown that people do prefer to advance undesirable outcomes when those outcomes are certain (Loewenstein, 1987; Mischel & Grusec, 1967; Thaler, 1981). On the other hand if the undesirable outcome is uncertain, then the consumer would rather delay the outcome (Lovallo & Kahneman, 2000). When a consumer chooses a pricing scheme, his or her evaluation of certainty or uncertainty of future utility may impact his or her preferences. A post-payment pricing scheme has a certain

future disutility from payment, while a pre-payment pricing scheme has either a certain or an uncertain future utility from consumption.

Consumers experience uncertain utility from future consumption in a variety of contexts. For example, when consumers consider trying out a new product or accessing a new digital environment, they cannot have a clear sense of the value of the experience that they are about to consume. In such cases consumers may be reluctant to prepay. In contrast, when the positive consumption value of a purchase is reasonably certain, consumers may wish to pay early. Such behavior allows consumers to "savor" their future consumption (Loewenstein, 1987).

Proposition 9: Consumers who are uncertain about the utility of future consumptions may prefer post-payment or pay-as-you-go pricing schemes over pre-payment pricing schemes.

Conclusions

In this chapter we drew on the behavioral economics literature to identify the conditions under which consumers would prefer one of three pricing schemes (pre-payment, pay-as-you-go, and post-payment). This research is motivated in large part by the influx of new payment technologies, as well as the behavioral research that hints that the relative timing of payment and consumption affects a consumer's purchase experience. Our findings should be of interest to information systems researchers, firms, and practitioners. We conclude that consumer preferences for particular pricing schemes are likely to be determined by systematic relationships that exist among a variety of psychological variables. As a first step in the direction of providing useful information to firms, practitioners, and future researchers, we offered nine empirical propositions. Empirical tests of these propositions may increase our understanding of the impact of different variables on consumers' payment preferences. An understanding of consumer preferences for pricing schemes may not only help firms design more acceptable payment systems, but it may also enable firms to use payment systems based on different pricing schemes as a strategic marketing tool.

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Endnotes

1 An *online payment system* is any method or process that is used to conduct a monetary transaction over the wired and wireless Internet.

2 Of course one's enjoyment of a prepaid vacation could be hampered by thoughts of one's new, impoverished state. Though it is an empirical question, we would predict that such negative thoughts peaked at the time payment was contemplated and offered.

3 Of course the difference between credit card and charge card vanishes for an individual who pays entire due amount at the end every billing cycle.

Chapter IX

Economics of Immediate Gratification in Mobile Commerce

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Abstract

In this chapter we attempt to build a bridge between mobile commerce and the emerging field of behavioral economics. We first provide examples from mobile commerce and link them to behavioral economics. We then build a stylized model to assess the impact of hyperbolic discounting on the profit-maximizing behavior of a monopolist firm. We find that the monopolist makes lower profits compared to exponential discounting consumers for low levels of (positive) network externalities. As the network externalities increase, first-period prices increase, second period prices decrease and the profits increase in equilibrium.

Introduction

Shopping is ubiquitous. Malls and individual shops face the first stage of expansion to the digital environment through fixed wired Internet. Electronic commerce initiates huge investments and leads to controversies as well as financial disappointments since the mid-1990s. From early 2000 onward we are facing a second wave of digital commercial growth. Wireless technologies are enabling individual consumers to access information wherever they are and whenever they want.

Although the use of mobile devices is evolving rapidly, the investigation of mobile consumer behavior is lacking. An increasing number of electronic commerce services for mobile devices coupled with swift adoption rates will enable mobile operators to provide effective customer services and gain competitive advantage. However, this can only be achieved by analogous deeper understanding of mobile users' behavior.

A tool to understand the consumer behavior within mobile context comes from the field of economics. Neoclassical economics approaches the individual as a rational decision maker faced with a series of consumption choices. The corresponding model of human behavior is called "*Homoeconomicus,"* who is endowed with perfect rationality, self-interest, and knowledge. In reality humans are largely driven by their emotions, and emotions are often irrational. They also perform altruistic acts like charity, volunteerism, lending a helping hand, parenting, and even giving one's life for one's country. These all fall contrary to the assumption of self-interest. They perform self-destructive acts like substance abuse, negative addiction, negative risk-taking, procrastination, inability to complete projects, masochism, and suicide. They are also highly ignorant about all their affairs; they can be expert in only a few topics at a time (Laibson, 2001). In parallel to the technology achievements in wireless communications, maybe relatively less rapidly, our understanding of the "homoeconomicus" is expanding toward a complementary economic perspective of the homosapiens. As we discuss in the next section, behavioral economics provides novel concepts using traditional tools. Our goal in this chapter is to discuss the viability of some of the mobile business models through the lens of behavioral economics.

Impact of Mobile Technology

In this section we provide an overview of the mobile commerce technologies that we believe impact consumers' decision making. We start with a definition of mobile commerce.

Definition: *Mobile commerce is defined as all activities related to a (potential) commercial transaction conducted through communications networks that interface with wireless (or mobile) devices.*

The most salient feature of mobile commerce is the availability of ubiquitous access to information whenever and wherever it is needed. Using a mobile device a customer can watch streaming video and complete financial transactions while on the road. Digital content is enriched when ubiquity is coupled with location and time-specific knowledge.

Constant access to information can increase efficiency and lower supplier costs for critical decision making. Examples include Siemens' wireless extension to SAP Business Warehouse backend system, UPS' tracking shipments using wireless devices, and Office Depot's logistics management system using custom wireless handheld units.

Coordination costs for buyers can also decrease. CitiGroup customers receive daily bank balance updates via SMS messages, and major brokerage firms such as Charles Schwab and Merill Lynch provide wireless access to aggre-

Table 1. Services used by Internet-enabled mobile phone users globally

Country (as % of IE-mobile users)	E-mail	Banking	Purchasing	Games
Asia	10%	2%	3%	3%
Brazil	11%	7%	1%	2%
Europe	10%	3%	1%	3%
Japan	77%	4%	12%	5%
North America	27%	6%	3%	7%
Worldwide	19%	3%	3%	3%

Source: AT Kearney, August 2002

Table 2. m-Commerce sales predictions (2001-2005)

Device	2001	2002	2003	2004	2005
Sales closed on devices (in billions)					
PDA	0.0	0.1	0.5	1.4	3.1
Cell Phone	0.0	0.0	0.0	0.1	0.3
Sales influenced by devices (in billions)					
PDA	1.0	5.6	14.4	20.7	24.0
Cell Phone	0.0	0.0	0.1	0.3	1.3

Source: Forrester Research, January 2002

Table 3. Current mobile phone users' interest in 3G applications

Application	W. Europe	E. Europe	USA
On 6-point interest scale, 6 = high interest and 1 = low interest			
E-mail	4.5	4.7	4.3
Payment Authorization/Enablement	3.4	3.8	3.0
Banking/Trading Online	3.5	3.4	3.2
Shopping/Reservations	3.0	3.1	2.9
Interactive Games	2.0	2.2	2.4

Source: Taylor Nelson Sofres, May 2002

gated account information. In this chapter we are interested in buyer-side impact of mobile technologies.

Although the number of mobile users is expanding, as Table 1 shows, the percentage of consumers using mobile channels to make purchases is very low, according to an AT Kearney study. According to Forrester, there is an upward trend on the expected sales of mobile devices by 2005. Interestingly, the interest in 3G applications focuses on financial and payment solutions after e-mail applications, according to a Taylor Nelson Sofres survey. These are all indications of increased use of mobile devices in the future for payment purposes.

Behavioral Economics of Mobile Technology

Instant gratification is key to the use of mobile devices. Mobile services that deliver context-dependent content to users fulfill the instant gratification behavior that consumers seek. According to a Jupiter report, consumer interest in purchasing items using a wireless device is not a priority, with only 7% expressing interest in conducting transactions via a wireless phone. The report adds that mobile commerce will be driven by a desire for instant gratification (www.jup.com).

In an attempt to increase the use of mobile devices for purchase, Alon USA LP, which operates Fina gas stations and 7-Eleven outlets in the Southwest, has established an "m-commerce" system using existing cellular telephone technology and already-installed point-of-sale systems. The company is using mobile-commerce payment technology developed by Cellenium Inc. in Englewood Cliffs, NJ, that will let any cellular telephone, including aging voice-only models, conduct a mobile transaction.

Each transaction is funneled through Alliance Data Systems Inc., which already provides transaction services to Alon and other gas station and convenience store operators. Alliance Data, Cellenium, and Alon have formed a partnership called Cellerate to manage, market, and promote their mobile-commerce system. The Cellerate software also keeps track of customers' premium points and, in Fina's case, can offer instant gratification by automatically controlling a voice-activated vending machine to provide a customer with a free soda.

There is also instant gratification through the consumption of digital products on mobile devices. Recent mobile purchase history of the customers shows that they want to buy downloadable features and extras like ring tones, games, and the ability to send digital photos. In order to satisfy this demand Handango sells digital content for mobile devices as well as software for handhelds. Nokia and MasterCard, banking on customers' desire for convenience, have done run trials of a quick-pay system that attaches to a cell phone. These efforts imply that cell phones are about instant gratification and making a social statement.

O'Donoghue and Rabin (1999, 2000) say that due to preference for immediate gratification, people under-indulge in activities that involve immediate costs and delayed rewards (for example, putting off an unpleasant but necessary task) but over-indulge in activities with immediate rewards and delayed costs (for example, overeating). Based on Strotz (1956) and Pollak (1968), O'Donoghue

and Rabin (1999; 2000) distinguished between two types of consumers — (i) sophisticates, people who know that their preferences may reverse due to immediate gratification, and (ii) naives, people who don't realize that their preferences may reverse due to immediate gratification. Naives exhibit immediate gratification behavior with respect to both immediate costs (procrastinate costs) and immediate benefits ("preproperate" benefits). Surprisingly, though sophisticates are able to tackle procrastination, they exacerbate immediate gratification behavior with respect to immediate benefits (O'Donoghue and Rabin, 1999).

Demand for instant gratification raises the issue of payment mechanisms available for related purchases. In the next section, we discuss economic characteristics of mobile payments.

Mobile Payments and Consumption

According to Celent, a financial services research and consulting firm, by 2004 there will be 60 million mobile payment users generating sales of $50 billion. A joint survey by Visa International and Boston Consulting predicts that combined e-commerce and m-commerce volumes will grow from $38 billion in 2002 to $128 billion in 2004.

There are increasingly more sophisticated devices that are developed together with new applications that take advantage of color screens, keyboards, and longer battery life. Introduction of these applications will drive the use of new payment opportunities that bridle the capabilities of wireless devices. Note that while these have been developed and are mostly also commercially available, their usage is indeed quite limited.

A rich example of mobile payment solutions can be found in Finland, as the country has the highest mobile phone penetration rate in Europe. Dynexco, a Finnish company, has launched a payment solution called DNX MobileMoney. A customer with a DNX account can transfer funds from his or her bank account and pay for purchases of goods or transfer funds to other DNX accounts in real time. Payment is based on text messages sent by a GSM phone or via the Internet (*www.dnxmobiiliraha.com*).

Sonera Shopper is another mobile payment solution. A customer opens a Shopper account and transfers money to it from his or her bank account. He

or she can pay for purchases at merchants who have joined the system by sending a text message. The customer can also pay for purchases out of his or her credit card account (Visa, Eurocard, MasterCard) instead of his or her Shopper account. In that case the customer's credit card number must be entered into the Shopper system and the customer decides when sending a text message which way he or she wants to pay (www.sonera.fi).

E-Pay sells branded services to merchants. At the moment these merchants include some restaurants and ski resorts. Also in this solution, the customer first registers for a service and has his or her own account opened. After that, he or she can transfer money to this account and pay for purchases and services via mobile phone.

Some purchases can also be aggregated to the customer's monthly mobile phone bill. Purchase of logos, ring tones, or chocolate bars from vending machines are included on the mobile bill at the end of the month. Similarly, using a service called Parkit, one can also pay for parking in some Finnish cities by calling a parking area service number. The parking fee will be included on the customer's telephone bill, credit card bill, or a separate bill, or the customer can pay for parking by Sonera Shopper.

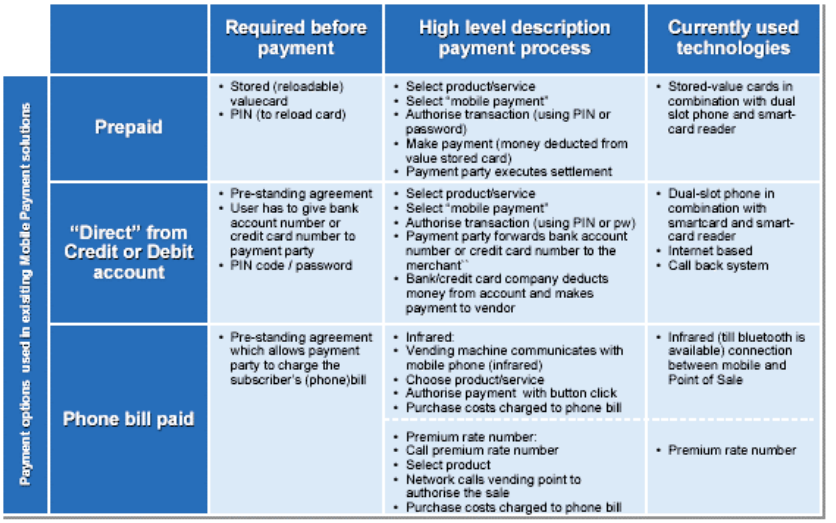
Outside Finland one of the most widespread mobile phone payment applications is the Germany-based paybox, which was launched in May 2000. This service enables the customer to purchase goods and services and make bank transactions via mobile phone. The value of purchases or credit transfers is debited from the customer's bank account (www.paybox.net).

In Spain a mobile payment solution called Mobipay is available that can be used for payments at real or virtual POS or vending machines. Person-to-person payments and paying for invoices are possible. Mobipay activates through existing payment means, that is, normal or virtual credit, debit, or prepaid cards (www.mobipay.com).

In Norway a customer can sign up for and open his or her own Payex account at Payex's website (www.payex.no) or he or she can send a text message. Before using their Payex account, customers must transfer money into it. Certain purchases can be paid by Payex via Internet.

In all the examples above, the payments are either done in real time or aggregated to the end of the month. The following table from a study by Arthur D. Little characterizes the current mobile payment solutions with respect to the timing of payments.

Figure 1. Mobile payments and their timing vis-a-vis consumption



Payment options used in existing Mobile Payment solutions	Required before payment	High level description payment process	Currently used technologies
Prepaid	• Stored (reloadable) valuecard • PIN (to reload card)	• Select product/service • Select "mobile payment" • Authorise transaction (using PIN or password) • Make payment (money deducted from value stored card) • Payment party executes settlement	• Stored-value cards in combination with dual slot phone and smart-card reader
"Direct" from Credit or Debit account	• Pre-standing agreement • User has to give bank account number or credit card number to payment party • PIN code / password	• Select product/service • Select "mobile payment" • Authorise transaction (using PIN or pw) • Payment party forwards bank account number or credit card number to the merchant`` • Bank/credit card company deducts money from account and makes payment to vendor	• Dual-slot phone in combination with smartcard and smart-card reader • Internet based • Call back system
Phone bill paid	• Pre-standing agreement which allows payment party to charge the subscriber's (phone)bill	• Infrared: • Vending machine communicates with mobile phone (infrared) • Choose product/service • Authorise payment with button click • Purchase costs charged to phone bill	• Infrared (till bluetooth is available) connection between mobile and Point of Sale
		• Premium rate number: • Call premium rate number • Select product • Network calls vending point to authorise the sale • Purchase costs charged to phone bill	• Premium rate number

Source: *Arthur D. Little*

Economic impact of such a separation in timing of payments and consumption cannot be fully explained using neoclassical economic theory but as the following section explains, behavioral economics can help complement the insights that can be gained from the classical theory of consumption and payments.

Hyperbolic Discounting

Hyperbolic discounting is a way of accounting in a model for the difference in the preferences an agent has over consumption now vs. consumption in the future. For α and g scalar real parameters greater than zero, under hyperbolic discounting events t periods in the future are discounted by the factor $(1+\alpha t)^{-g/\alpha}$. The expression "hyperbolic discounting" describes the "class of generalized hyperbolas." This formulation comes from a 1999 working paper of C. Harris and D. Laibson, which cites Ainslie (1992) and Loewenstein and Prelec (1992). In dynamic models it is common to use the more convenient

assumption that agents have a common discount rate applying for any t-period forecast, starting now or starting in the future.

One reason hyperbolic preferences are less convenient in a model is not only that there are more parameters but also that the agent's decisions are not time-consistent as they are with a constant discount rate. That is, when planning for time two (two periods ahead), the agent might prepare for what looks like the optimal consumption path as seen from time zero; but at time two his preferences would be different (About.com, 2003).

In a simple model of a two-period monopoly firm, we compare the profits and prices for two cases. Our benchmark case is the standard exponential discounting that we assume both firms and consumers adopt. In the case of hyperbolic discounting we fix the α parameter in a specific form of hyperbolic discounting:

$$\frac{1}{1+\alpha t}.$$

In both cases second-period sales of the monopoly firm face positive network externalities from the first period. This represents the mobile firms' customer base and its impact on the use of (mobile) technology at a later stage.

In order to build our model, we use the following notation:

Variable	Description
p_1	First-period price
p_2	Second-period price
Π	Profit
e	Level of network externality
δ	Exponential discount factor
α	Hyperbolic discount parameter

We assume that the consumers are distributed uniformly along the [0,1] interval. The firm knows the distribution of the consumers but not their exact location. In the first period the net consumer surplus is $v_1 = u - p_1$. In the second period the net consumer surplus with hyperbolic discounting is:

$$v_2 = \frac{1}{1+\alpha}(u - p_2 + e(1-u));$$

with exponential discounting, it is given by $v_2 = \delta(u - p_2 + e(1-u))$.

For the hyperbolic discounting case, we find the marginal consumer who is indifferent between consumption in either periods by equating the net consumer surpluses from each period and solve for *u*:

$$u_1^* = \frac{e + (1+\alpha)p_1 - p_2}{e+\alpha}$$

Similarly, the marginal consumer indifferent between buying or not buying in the second period is given by

$$u_2^* = \frac{p_2 - e}{1-e}$$

The derived demand functions are then given by

$$D_1 = 1 - u_1^*$$
$$D_2 = u_1^* - u_2^*$$

Thus the profit function of the monopoly firm is simply $\Pi = p_1 D_1 + \delta p_2 D_2$.

The maximization problem we solve to find the optimal prices and profit level is the following:

$$\max_{p_1, p_2} \Pi$$
$$D_1 \leq 1$$
$$D_2 \leq 1$$

$$u_2^* \geq 0$$
$$p_1, p_2 \geq 0$$

The lagrangian that corresponds to the problem above is:

$$\ell = \Pi - \lambda_1(D_1 - 1) - \lambda_2(D_2 - 1) - \lambda_3(-u_2^*) .$$

Finally, the system we solve is given by

$$\frac{d\ell}{dp_1} = \frac{d\Pi}{dp_1} - \lambda_1(-\frac{(1+\alpha)}{e+\alpha}) - \lambda_2(\frac{(1+\alpha)}{e+\alpha})$$
$$\frac{d\ell}{dp_2} = \frac{d\Pi}{dp_2} - \lambda_1(\frac{1}{e+\alpha}) - \lambda_2(-\frac{1}{e+\alpha} - \frac{1}{1-e}) - \lambda_3(-\frac{1}{1-e})$$
$$\lambda_1(D_1 - 1) = 0$$
$$\lambda_2(D_2 - 1) = 0$$
$$\lambda_3(-u_2^*) = 0$$
$$p_1, p_2, \lambda_1, \lambda_2, \lambda_3 \geq 0$$

The only feasible solutions to this system are given below.

Case 1: $\lambda_1 > 0, \lambda_2 = \lambda_3 = 0$

The solution in this case is

$$\lambda_2 = \frac{(-1+e)(e+\alpha) + (1+\alpha)(-1+e+2e^2-3\alpha+5e\alpha)\delta + (-1+e)^2(1+\alpha)^2\delta^2}{2(1+\alpha)^2}$$
$$p_1 = \frac{e+\alpha+(1-e)(1+\alpha)\delta}{2(1+\alpha)}$$

$$p_2 = \frac{e + e^2 - \alpha(1+3e) + (1-e)^2(1+\alpha)\delta}{2(1+\alpha)}$$

$$\Pi = \frac{(e+\alpha)^2 + 2(1+\alpha)(e+e^2-\alpha(1+3e))\delta + (1-e)^2(1+\alpha)^2\delta^2}{4(1+\alpha)^2}$$

$$D_1 = \frac{e+\alpha-(1-e)(1+\alpha)\delta}{2(1+\alpha)}$$

$$D_2 = 1$$

For this solution to yield positive prices and demand, the following conditions need to hold:

$$\delta < \frac{\alpha}{1+\alpha}, e < \min\{\frac{\alpha-(1+\alpha)\delta}{1-(1+\alpha)\delta}, 1\}.$$

Case 2: $\lambda_1 = \lambda_2 = \lambda_3 = 0$

This is the interior solution, which yields

$$p_1 = \frac{(1+\alpha)\delta((2-e)(e+\alpha)+(-1+e)e(1+\alpha)\delta)}{(e+\alpha-(-1+e)(1+\alpha)\delta)^2}$$

$$p_2 = \frac{e+\alpha}{e+\alpha+(1-e)(1+\alpha)\delta}$$

$$\Pi = \frac{(1+\alpha)\delta(\alpha(1+e(-1+\delta))+e\delta)}{(-1+e)(-1+e+2(1+\alpha)(1+e+2\alpha)\delta+(-1+e)(1+\alpha)^2\delta^2)}$$

$$D_1 = \frac{(1+\alpha)\delta(1+\alpha(2-\delta)-\delta)}{(-1+e+2(1+\alpha)(1+e+2\alpha)\delta+(-1+e)(1+\alpha)^2\delta^2)}$$

$$D_2 = \frac{(1+\alpha)(1-e-(1+e)(1+\alpha)\delta)}{(-1+e)(-1+e+2(1+\alpha)(1+e+2\alpha)\delta+(-1+e)(1+\alpha)^2\delta^2)}$$

Case 3: $\lambda_1 = 0, \lambda_2 > 0, \lambda_3 > 0$

$$\lambda_2 = e\delta - \frac{e+\alpha}{1+\alpha}$$
$$\lambda_3 = \frac{e+\alpha}{1+\alpha} - (1-e)\delta$$
$$p_1 = \frac{e+\alpha}{1+\alpha}$$
$$p_2 = e$$
$$\Pi = e\delta$$
$$D_1 = 0$$
$$D_2 = 1$$

For this system to yield a feasible solution:

$$e > \frac{e+\alpha}{\delta(1+\alpha)} > (1-e) \text{ and } e > \frac{1}{2} \text{ has to hold.}$$

Case 4: $\lambda_1 = \lambda_2 = 0, \lambda_3 > 0$

This yields the following

$$\lambda_3 = \frac{(-1+e)(e+\alpha) + (1+\alpha)(2e^2 - \alpha + 3e\alpha)\delta + (-1+e)e(1+\alpha)^2\delta^2}{2(1+\alpha)(e+\alpha)}$$
$$p_1 = \frac{e+\alpha+e\delta(1+\alpha)}{2(1+\alpha)}$$
$$p_2 = e$$
$$\Pi = \frac{(e+\alpha+e(1+\alpha)\delta)^2}{4(1+\alpha)(e+\alpha)}$$

$$D_1 = \frac{1}{2} - \frac{e(1+\alpha)\delta}{2(e+\alpha)}$$

$$D_2 = \frac{1}{2} + \frac{e(1+\alpha)\delta}{2(e+\alpha)}$$

For this to yield a feasible solution,

$$e < \frac{1}{\delta(1+\alpha)}$$

has to hold.

Following figures show the cases for which the exponential discounting parameter is set at $\delta = 0.9$ and the hyperbolic discounting parameter is $\alpha = 0.2$. For this example, we see that the profits when consumers are believed to have hyperbolic discounting are lower for low levels of network externalities. As the network externality effect increases, the profits also increase. This may be due to the fact that the monopoly can benefit from those consumers who value first-period consumption over the second period by charging them higher than the exponential discounting case for high levels of network externalities. This is also

Figure 2. Profits and first-period price of a monopoly firm with and without hyperbolic discounting of the consumers (Alpha represents the hyperbolic discounting parameter.)

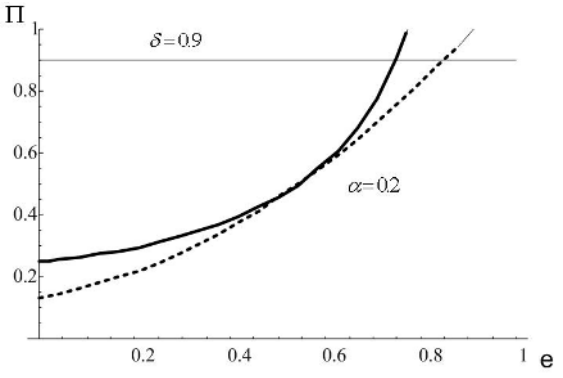
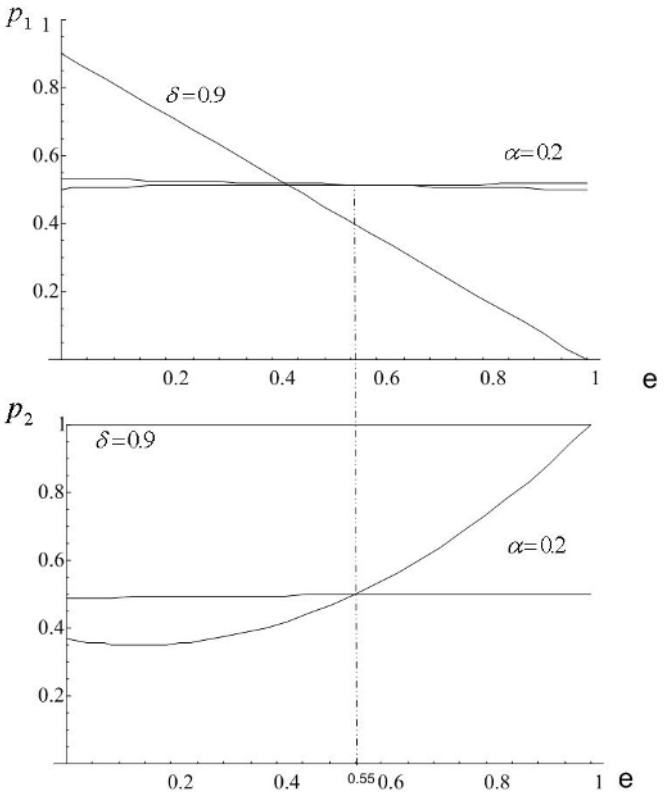


Figure 3. First and second period prices with and without hyperbolic discounting of the consumers (Alpha represents the hyperbolic discounting parameter)



seen in Figure 3, where for high levels of *e* first-period price is higher in the hyperbolic discounting case than the exponential discounting.

The monopoly can then add to the profits by charging less in the second period in order to avoid the Coase conjecture, which predicts market failure in the second period for such a monopoly firm. This can be easily seen in Figure 3, where first-period price under exponential discounting decreases as network externalities increase but the second-period price remains at its highest possible rate. The neoclassical monopolist tries to charge lower prices in the first period to attract consumers in the hopes of charging them a higher price in the second

period. In this case the market share in the first period is ½, whereas the second-period market share is 0. This implies that the monopoly firm sells only in the first period, as the consumers expect to be charged a higher price in the second period.

The outlook changes once we introduce hyperbolic discounting. The first-period market share becomes

$$\frac{1}{2} - \frac{0.855e}{0.9+e},$$

which is decreasing but positive in e, converging to 0.05, while the second-period market share is

$$\frac{0.9+2.71e}{2(0.9+e)},$$

which is increasing in e, converging to 0.95. Hence, by taking instant gratification, or present biased preferences, into account, the monopoly can benefit from smoother pricing in the first period and gradually increasing second-period pricing.

Conclusions

Behavioral economics provides new perspectives to understand various aspects of consumers' consumption and payment behavior. In this chapter we highlight some of the aspects that we believe can help technology companies form market strategies, especially in the mobile commerce area.

Mobile devices provide a new frontier for firms to reach consumers. They enable companies to better comprehend consumers' purchasing behavior by tracking their spending and consumption patterns in real time. We show that this understanding may help firms make more profits and better position themselves in the marketplace.

Mobile payments and consumption inherit characteristics that can be explained using concepts from behavioral economics. Instant gratification, mental accounting, and hyperbolic discounting are a few that we focus on in this paper. We build a stylized model that compares exponential to hyperbolic discounting within a network externalities framework. We find that when consumers are assumed to have present biased preferences, which is usually the case for instant gratification, as the literature suggests, a monopolist may make more profits and charge more strategically to keep all the consumers purchasing his or her services.

Although we do not mention it in this chapter, the wealth of the consumer, and hence the size of the payment, is as important as the timing of the payments: buying a latte is no pain at all, buying a restaurant meal is a minor pain, buying a computer is a major pain, and buying a car is a massive pain. Consequently the use of mobile payments will be confined to medium- to low-value items until/unless mobile phones are accepted by the consumers as payment instruments.

On the technology side there are emerging payment tools such as Bluetooth-enabled point of sale devices. Global wireless access to any media (voice, data, video) mobile services from/to wherever you may be (homes, offices, hotels, airports, in the air, or at the beach) and for any device (cell phones, PDAs, Internet-aware appliances, ATMs, POS devices, Kiosk, PCs, laptops, and so forth) is already available. Bluetooth, WAP, DSL, and cable modems that integrate seamlessly, Personal Area Networks (PAN), devices with long-distance high-bandwidth wired/wireless Internet, and public telephone network access make it possible.

Bluetooth's advantage is that it is much less expensive to implement. Thus it can be used in various POS devices. A supermarket in Sweden, ICA Ahold, completed a successful test of wireless Bluetooth payments enabled by Ericcson phones in 2000. Customers used their mobile telephones to make purchases, check their account balances, and receive special offer information. Bluetooth sends wireless signals between devices equipped with a Bluetooth chip on the 2.45 GHz ISM band. Depending on the strength of the signal, compatible Bluetooth devices can communicate at distances of up to 80 meters, although distances of up to 10 meters are more common. Lack of standards is slowing the wide adoption of Bluetooth payment systems. Security is also a concern, since Bluetooth can transmit messages over relatively long distances, which poses a greater threat to payment information since it can be intercepted en route.

Radio Frequency Identification Device (RFID) is another technology solution that has a wide application and direct impact on the payment systems. Since 1997 this technology has been used in ski passes in Switzerland and in Swatch watches, some of which can store credit, as well as more recently in London Underground electronic tickets.

A retail outlet using RFIDs can allow consumers to walk out of the store while charging the card they set up previously. RFIDs prevent theft, help guarantee quality, and provide absolute 100% precision about what stock remains in the food store and when products are close to sell-by dates. They also mean a consumer can pay for products and services ranging from bottles of wine to travel tickets using a card that never leaves their pocket. This will obviously increase the separation between payments and consumption further, making payments more transparent and the pain less apparent. One can foresee the negative impact on the level of debt the consumers might accumulate in the United States.

There are several dimensions over which this work can be extended. We use a very simple model of hyperbolic discounting. The model can be extended to include a more generalized form of hyperbolic discounting function, and instead of two periods, multiple periods can be considered. Mental accounting can also be an important avenue to explore. For initial work in this area, see Balasubramanian, Dutta, and Tomak (2003) or Balasubramanian and Tomak (2003).

Finally, behavioral economics provides new policy guidance to financial and governmental institutions that look into regulating or deregulating competition in mobile telecommunications markets. This is especially important when financial debt in the U.S. has reached new heights.

A cross-cultural study to assess the international differences in consumption and payments as well as present biased preferences can be extremely interesting. For instance, a Finland-U.S. comparison would potentially reveal major differences, not only at the consumer level, but also at the legislative and policy levels. Unlike in Finland, in the U.S. personal bankruptcy is a right that consumers can exercise whereas in Finland "only death" can free one from his or her accumulated debt.

Considering these implications of payment systems and understanding payments and consumption in this new area of mobile technology-based consumption may increase social welfare and ensure ignorance will never be a bliss for the future generations.

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Glossary

Access provider: The company that provides you with Internet access and, in some cases, an online account on their computer system.

Application: Software that lets users do relatively complex tasks, as well as create and modify documents. Common application types include word processors, spreadsheets, database managers, and presentation graphics programs.

B2B: On the Internet, B2B (business-to-business), also known as e-biz, is the exchange of products, services, or information between businesses rather than between businesses and consumers.

Bandwidth: How much stuff you can send through a connection. Usually measured in bits-per-second. A full page of English text is about 16,000 bits. A fast modem can move about 57,000 bits in one second. Full-motion full-screen video would require roughly 10,000,000 bits-per-second, depending on compression.

Broadband system: A broadband system is capable of transmitting many different signals at the same time without interfering with one another. For local

area networks, a broadband system is one that handles multiple channels of local area network signals distributed over cable television (CATV) hardware.

Circuit-switched: A type of network connection that establishes a continuous electrical connection between calling and called users for their exclusive use until the connection is released. Ericsson PBX is a circuit-switched network.

Client/server relationship: A client application is one that resides on a user's computer but sends requests to a remote system to execute a designated procedure using arguments supplied by the user. The computer that initiates the request is the client and the computer responding to the request is the server. Many network services follow a client and server protocol.

Coase's theory: The belief that externalities can be accounted for in a production process by the consumer of an externality agreeing on a price with the producer first.

Competitive markets: Markets where firms are generally free to enter or leave a market.

Complementary products: Two goods used together by consumers, for example, bread and butter.

Consumer equilibrium: When a consumer is maximizing satisfaction from his/her purchases. This maximization will happen where the marginal utility/price ratios are equal for all goods the consumer is consuming.

Consumer surplus: This occurs when people are able to buy a good for less than they would be willing to pay. They enjoy more utility than they had to pay for.

Cross elasticity of demand: Measures the responsiveness of demand for good A to a given change in the price of good B. It is an important piece of information to a firm as it helps them predict how much the demand for their

product will change as the price of other goods change. We calculate the cross price elasticity from the following formula: Cross price elasticity of demand = % change in demand for good A / % change in the price of good B. If the figure is greater than one, then the product is described as "elastic," or sensitive. This means that demand will change by more than the change in the price of the other good. If the figure is less than one, then the product is described as "inelastic" and the demand will change to be proportionately less than the price of the other good. The sign of the cross price elasticity gives important information. If the cross price elasticity of demand is positive, then this implies that the two goods are substitutes. A negative sign implies that they are complementary goods.

Cross-platform: Refers to software (or anything else) that will work on more that one platform (type of computer).

Cyberspace: A term used to refer to the electronic universe of information available through the Internet.

Derived demand: The amount of demand for good A depends in turn on the amount of demand for good B, for example, an increase in the demand for houses creates a direct demand for bricklayers.

Differentiated goods: Goods or services that are distinguished from rival products by, for example, packaging, advertising.

Differentiation: A strategy that offers the same goods at different prices for different sectors of the market.

Discriminating monopoly: A sole producer who divides up the market and charges different prices to different groups of customers.

Economic rent: A surplus paid to any factor of production over its supply price. Economic rent is the difference between what a factor of production is earning (its return) and what it would need to be earning to keep it in its present use. It is in other words the amount a factor is earning over and above what it could be earning in its next best alternative use (its transfer earnings).

Elasticity of demand: The elasticity of demand indicates the responsiveness of demand to a change in a determinate, for instance, price, price of other goods, and income.

Encoding: File transfer formatting that enables encrypted, compressed, or binary files to be transferred without corruption or loss of data.

Equilibrium price: The price where the quantity supplied by firms equals the quantity demanded by households. In other words there is no shortage or surplus within the market.

Ethernet: An IEEE 802.3 standard data link layer that can operate over several different media, including fiber optic, coaxial cable, and twisted-pair cable. This 10 million-bit-per-second networking scheme is widely used on campuses because it can network a wide variety of computers; it is not proprietary, and components are widely available from many commercial sources.

Externalities: The spillover effects of production or consumption for which no payment is made. Externalities can be positive or negative. For example, all fax users gained as new users become connected (positive); and smoke from factory chimneys (negative).

Extranet: An intranet that is accessible to computers that are not physically part of a company's own private network but that is not accessible to the general public — for example, to allow vendors and business partners to access a company web site.

File server: A computer that shares its resources, such as printers and files, with other computers on the network. An example of this is a Novell NetWare Server that shares its disk space with a workstation that does not have a disk drive of its own.

Imperfect competition: Covers market structures between perfect competition and monopoly, that is, an industry with barriers to entry and differentiated products.

Information technology: Includes matters concerned with the furtherance of computer science and technology, design, development, installation, and implementation of information systems and applications.

Internet: The Internet (note the capital I) is the largest Internet in the world. It is a three-level hierarchy composed of backbone networks (for example, NSFNET, MILNET), mid-level networks, and stub networks. The Internet is a multiprotocol internet.

IP: Internet Protocol is the standard that allows dissimilar hosts to connect to each other through the Internet. This protocol defines the IP datagram as the basic unit of information sent over the Internet. The IP datagram consists of an IP header followed by a message.

ISO: International Organization for Standardization, the group that developed the OSI protocols.

ISP: Internet Service Provider. An institution that provides access to the Internet in some form, usually for money.

ISP: Internet Service Provider. A company that provides access to the Internet. A service provider can offer simple dial-up access, SLIP/PPP access, or a dedicated line.

LAN: Local Area Network. A network of directly connected machines (located in close proximity) providing high-speed communication over physical media such as fiber optics, coaxial cable, or twisted pair wiring.

Liquidity: Liquidity refers to the ease with which an asset such as bank deposits or property can be turned into money. Liquid assets are ones that can quickly be converted to cash.

Marginal revenue: The income received from the sale of one extra unit

Market failure: Market failure occurs when the workings of the price mechanism are imperfect and result in an inefficient or grossly unfair allocation of resources from the perspective of society. Examples include the education and defense markets.

Market segment: A particular group of consumers within a market.

Mobile commerce: M-commerce (mobile commerce) is the buying and selling of goods and services through wireless handheld devices such as cellular telephones and personal digital assistants (PDAs).

Monopoly: In theory an industry where one firm produces the entire output of a market. In practice, in the United Kingdom, any one firm that has 25% of a market is considered to have monopoly control.

Monopsony: A market where there is only a single buyer of a good.

Native: Software that's written specifically to run on a particular processor. For example, a program optimized for a 68K processor runs in native mode on a Quadra, but it runs in emulation mode (which is slower on a Power PC-based Power Mac). Also the file format in which an application normally saves it documents. The native format is generally readable only by that application (other programs can sometimes translate it using filters).

Network: In general a group of computers set up to communicate with one another. Your network can be a small system that's physically connected by cables (a LAN), or you can connect separate networks together to form larger networks (called WANs). The Internet, for example, is made up of thousands of individual networks.

Node: A computer that is attached to a network; sometimes called a host.

Normal goods: Goods to which the general law of demand tends to apply.

NSFNET: National Science Foundation Network. The NSFNET is a high-speed network of networks that is hierarchical in nature. At the highest level is a backbone network that spans the continental United States. Attached to that are mid-level networks, and attached to the mid-levels are campus and local networks. NSFNET also has connections out of the U.S. to Canada, Mexico, Europe, and the Pacific Rim. The NSFNET is part of the Internet.

Oligopoly: A market dominated by a very few sellers who account for a large proportion of output.

Online: Actively connected to other computers or devices. You're online when you've logged on to a network, BBS, or online service. A device such as a printer is online when it's turned on and accessible to a computer. If you're not online, then you're off-line.

Online service: A commercial service that (for a price) provides goodies such as e-mail, discussion forums, tech support, software libraries, news, weather reports, stock prices, plane reservations, even electronic shopping malls. To access one, you need a modem. Popular online services include America Online, CompuServe, and Prodigy.

Packet-switching: Data transmission process, utilizing addressed packets, whereby a channel is occupied only for the duration of the packet transmission. SDSUnet is a packet-switching network.

Peer-to-peer: A network setup that allows every computer to both offer and access network resources, such as shared files, without requiring a centralized file server. Macintosh computers utilize this type of network setup.

Price discrimination: When the same product is sold in different markets for different prices. A firm will only be able to price discriminate where there is separation between the markets. If there is any significant leakage between the markets, the price discrimination will break down.

Private good: A private good is one that is both rival and excludable. One person's consumption will mean that the good is not available for another person to consume it.

Protocols: When data is being transmitted between two or more devices, something needs to govern the controls that keep this data intact. A formal description of message formats and the rules two computers must follow to exchange those messages. Protocols can describe low-level details of machine-to-machine interfaces (for example, the order in which bits and bytes are sent across wire) or high-level exchanges between application programs (for example, the way in which two programs transfer a file across the Internet).

Public goods: Items that can be jointly consumed by many consumers simultaneously without any loss in quantity or quality of provision, for example, a lighthouse. Public goods are therefore goods that would not be provided in a pure free-market system. This is because they display two particular characteristics: 1. Non-rivalry - Consumption by one person does not reduce the amount available for others. 2. Non-excludability - Once the good is provided, it is impossible to stop people from consuming it even if they haven't paid. An example of this is defense. It is impossible to charge people for defense, as they consume it as the whole country is being defended at once. Also one person being defended does not stop others being defended.

Search engines: A type of software that creates indexes of databases or Internet sites based on the titles of files, key words, or the full text of files.

Skimming: A pricing policy sometimes used by companies introducing a new product. A high price is set to ensure large profits are made before the competitors are able to produce a similar product.

Subsidies: Payments to producers or consumers designed to encourage an increase in output.

Substitution effect: This occurs when a change in the relative price of a good causes the consumer to review how much they consume. For instance, if the

price rises, then this will reduce the relative income of an individual who does not change their consumption patterns.

TCP/IP: Transmission Control Protocol/Internet Protocol. A set of protocols, resulting from ARPA efforts, used by the Internet to support services such as remote login (TELNET), file transfer (FTP), and mail (SMTP).

Total utility: The amount of satisfaction obtained by consuming units of a good.

Transaction costs: All the costs associated with buying and selling a good, for example, the cost of finding out information.

Transfer payments: Transfer payments are payments for which no good or service is exchanged. In other words, money has simply been transferred from one person in society to another. This includes things like benefits, pensions and lottery payments. A significant proportion of government expenditure is on transfer payments.

USENET: A network of newsgroups. There are thousands of newsgroups available through USENET. Each one covers a specific topic or subject area.

Vertical integration: Vertical integration is where firms at different stages of the production chain merge together.

Web browser: Also known as a Web client program, this software allows you to access and view HTML documents. Netscape, Mosaic, Lynx, WinWeb, and MacWeb are some examples of Web browsers.

Web page: A document created with HTML that is part of a group of hypertext documents or resources available on the World Wide Web.

Wide Area Network (WAN): Network spanning multiple geographic distances, usually connected by telephone lines, microwave, or satellite links.

WWW: World Wide Web, or W3, is the hypermedia document presentation system that can be accessed over the Internet using software called a Web browser.

Zero sum game: A zero-sum game occurs when any gain made by one player is exactly balanced by losses to other players.

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