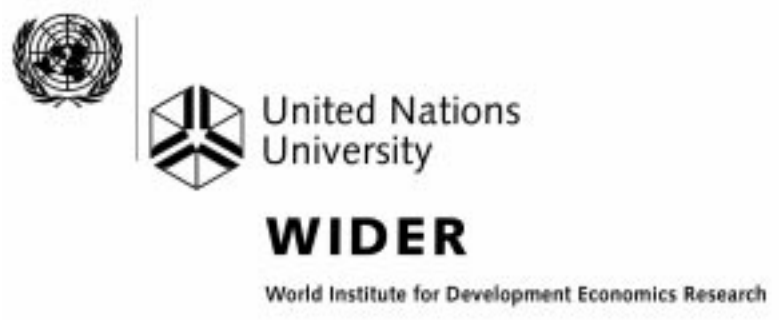

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Microeconomic Policies in the New Economy

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Abstract

The core industries of the new information economy are characterized by imperfect competition, asymmetric information or external effects. Thus, well-designed microeconomic policies, in the form of competition policies, technology policies or combinations of these, have strong potential of generating welfare improvements and promoting social efficiency. This paper emphasizes innovation-intensive competition, strong technological scale economies, network effects and complementarity between system components as characteristic features of the core industries in the information economy. With reference to these features the study explores the implications for microeconomic policies from the point of view of competition analysis.

The combination of strong technological scale economies on the supply side and network effects on the demand side makes market structures with high concentration and dominant firms both likely and efficient. On the other hand, a firm possessing a dominant market position and operating in a network industry has access to a more efficient set of instruments in order to abuse its dominant market position relative to a firm operating in a traditional industry. This study argues that the recognition of these

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two counteracting aspects forms a necessary condition for the design of successful microeconomic policies in contemporary high-tech markets. It is also emphasized that efficient competition policy in these markets has to face an inherent structural trade-off between the exploitation of strong scale economies and the promotion of entry and small enterprises.

1 Introduction

Ever since the days of Adam Smith's 'indivisible hand' the idea that a free and decentralized market economy will generate a socially optimal allocation has been alive among economists. This view was formalized in the famous contributions to the general equilibrium theory by Debreu (1959) and Arrow and Hahn (1971). Since then analytical research in the general equilibrium theory has offered a much richer characterization of a competitive equilibrium and, in particular, its implications for social efficiency as well as its restrictions. Broadly speaking, a free and decentralized market economy represents a socially optimal allocation. However, conditions characterized by imperfect competition, asymmetric information or external effects make competitive equilibria socially inefficient. The overall goal of microeconomic policies is to promote social efficiency by affecting either the competition strategies of firms or the organization of industries in order to reduce the distortions created by competition under such market conditions.

The core industries of the new information economy are characterized by imperfect competition, asymmetric information or external effects. Consequently, in many circumstances well-designed microeconomic policies, in the form of competition policies, technology policies or combinations of these, have the potential of generating welfare improvements and promoting social efficiency. This study attempts to present a characterization of selected features of the core industries in the new information economy and to explore the crucial microeconomic consequences of the technological revolution behind the emerging 'new' information economy from the point of view of competition analysis. In particular, we explore the challenges created by innovation-intensive core industries in the information economy for the authorities implementing competition and technology policies.

Most industrial nations have experienced a transition to an information-based economy in the sense that information and communication technology (ICT) comprises an ever-greater share of GDP and boosts productivity and economic growth as surveyed by Jalava and Pohjola (2001). They demonstrate that the contribution from the use of ICT to output growth in the market sector has increased from 0.3 percentage to 0.7 points during the 1990s in Finland for example, which is one of the leading ICT producers in Europe. In fact, the importance of the new information economy to the global corporate landscape is illustrated by Table 1, which shows how the top technology and telecomms stocks are placed in *The Financial Times* 2001 ranking of the world's 500 largest companies (on the basis of market value). This list documents a clear US-dominance among the largest ICT companies. The figures reported measure market values calculated on 4 January 2001. Thus, the dotcom and telecommunications meltdown, which began in the spring of 2000, is partly reflected in this table.

This article initially offers a systematic discussion of the typical features of the core industries in the new information economy. We then proceed to successively explore some crucial implications for microeconomic policies, in particular competition and technology policies. Finally we delineate some prevalent business practices with a clear policy-relevance from the point of view of microeconomic policies.

Table 1
Top technology and telecomms stocks by market capitalization as of 4 January 2001
(in billions of US dollars)

Company	FT500 rank 2001	Country	Market value $ billion	Sector
Cicso Systems	2	US	304.7	Telecomm. equipment
Microsoft	5	US	258.4	Software
Vodafone Group	8	UK	227.1	Wireless telecomm. services
Intel	9	US	227.0	Semiconductors
Nokia	12	Finland	197.5	Telecomm. equipment
Oracle	14	US	182.3	Software
NTT DoCoMo	16	Japan	175.4	Wireless telecomm. services
SBC Communic.	17	US	174.8	Fixed-line telecomm. services
IBM	18	US	164.1	Computer hardware
Emc	20	US	156.0	Computer hardware
Verizon Comm.	21	US	147.9	Fixed-line telecomm. services
NTT	29	Japan	116.7	Fixed-line telecomm. services
Nortel Networks	30	Canada	113.4	Telecomm. equipment
China Mobile H K	34	Hong Kong	102.3	Wireless telecomm. services
Sun Microsystems	35	US	101.1	Computer hardware
AOL	36	US	100.3	Internet
France Telecom	39	France	96.7	Fixed-line telecomm. services
Deutsche Telekom	40	Germany	94.7	Fixed-line telecomm. services
Ericsson	43	Sweden	91.0	Telecomm. equipment
Texas Instruments	44	US	90.4	Semiconductors
Bellsouth	53	US	81.2	Fixed-line telecomm. services
AT & T	54	US	79.0	Fixed-line telecomm. services
Qwest Comm. Int.	59	US	75.9	Wireless telecomm. services
Telefonica	61	Spain	75.5	Fixed-line telecomm. services
Alcatel	67	France	68.3	Telecomm. equipment
Hewlett-Packard	68	US	67.3	Computer hardware
Telecom Italia Mobile	74	Italy	64.7	Wireless telecomm. services
Qualcomm	80	US	59.5	Telecomm. equipment
British Telecom	81	UK	59.0	Fixed-line telecomm. services
Telecom Italia	84	Italy	57.8	Fixed-line telecomm. services

Source: *The Financial Times* (2001).

2 Characteristics of the core industries in the New Economy

Competitive strategies in the fast-changing information economy are distinct from strategies in the more traditional or static sectors of the economy. Therefore microeconomic policies, for example competition policy, must be attuned to the new strategies firms are employing. While durable monopoly power has always been rooted

in underlying scale economies, the sources and magnitude of those scale economies, and thereby the resulting barriers to entry, have changed as a consequence of the shift to the network economy. Demand-side economies of scale associated with network externalities are particularly important in many dynamic high-tech industries and this form of scale economies adds to traditional, technologically determined scale economies on the supply side.

At the risk of over-simplifying, we can characterize a number of typical features associated with the core industries in the information economy. This list of typical features has some common elements with the one presented by Shapiro (2000). Understanding and recognizing these features is of key importance for the design of microeconomic policies.

2.1 Innovation-intensive competition

Rapid innovation with short product-cycles is a key characteristic of the information economy. In industries undergoing frequent technological revolutions, we can typically identify cycles comprising two phases: an innovation phase and an imitation phase. Innovating firms participating in the innovation phase may acquire a dominant market position and during this phase the profit margins are protected by imperfect competition due to inherent technological entry barriers. Over time these technological entry barriers break down as intra- and inter-industry spillovers make it possible for imitating firms to profitably enter the market and successively reduce the sustainable profit margins. Thus, we can expect substantial profit margins to be sustainable only in the innovation phase. Without investments into innovation no firm can maintain a dominant market position in the long run. Just imagine, for example, what Nokia's market share would be a couple of years from now if it left innovation to Siemens, Ericsson, Motorola and a number of Japanese firms with the capability of creating mobile phones with superior technological features. It would, of course, plunge, making recovery extremely costly. Consequently in the long run, competition within the information economy can be classified as innovation-intensive Schumpeterian competition, where the firms are engaged in a race for capturing future market shares within upcoming generations of new technology. In this environment the firms have to make irreversible investments in the presence of a substantial degree of uncertainty. In the short run, and with the prevailing incumbent technology, competition takes place along traditional dimensions like price.

Against this background it seems intuitively hard to explain the hysterically optimistic expectations which were reflected in the stock prices of firms belonging to the core industries of the information economy immediately after the millennium. Clearly, in a historical perspective, P/E-ratios of technology stocks, and the IT-companies in particular, have been at previously unseen levels (see Shiller 2000). Isn't such an observation logically inconsistent with the inherent short product-cycles of these industries characterized by innovation-intensive competition, where successive generations of new technology replace the previous with relatively high frequency? Is there possibly the risk that investors have extrapolated the future potential of sustainable profit-generation in the long run for these technology companies from a perspective rooted in an innovation phase without taking into account that potential future entrants into these industries will have inherently stronger incentives to invest in new generations of technology?

Table 2
Revenues from European 3G mobile spectrum auctions completed in 2000

Country	Euros per capita
Austria	100
Germany	615
Italy	240
Netherlands	170
Switzerland	20
UK	630

It is indeed possible to refer to the fast growth of intangible capital during the 1990s as an explanation for the extraordinary rise of the stock market in the United States. Hall (2000) has recently incorporated a particular type of intangible asset, e-capital, into an extended model of technology and productivity growth in order to explain how the stock market boom simply reflects the market value of this e-capital. In Hall's model, e-capital is defined as the general business methods based on computers. This e-capital is exhibited in the body of technical and organizational knowhow created by well-educated human capital. It is also possible to design rational explanations for the highly volatile stock market valuations relative to earnings of technology companies. Noe and Parker (2000) have developed a model for the valuation of web-based firms based on a 'winner-takes-all' structure of high-fixed-cost, low-marginal-cost markets for information goods. Within such a context, they show how competition between websites may yield highly volatile and uncertain payoffs as well as highly skewed return distributions.

In recent years auctions have played an increasingly important role for the development of many high-tech industries. Governments have designed auction-based procedures for allocating assets such as mobile-phone licenses and frequencies. As an illustration, Table 2 shows the price per capita raised for rather similar blocks of spectrum frequencies sold for third-generation mobile phone services in six European countries during year 2000. These spectrum auctions cumulatively raised approximately US$100 billion, which constitutes more than 1.5 per cent of the combined GDP of these countries. Similarly the emergence and growth of e-commerce have encouraged the process of substituting bilateral negotiations with auctions as a trading mechanism.

Even though the per capita revenue from the spectrum auctions can be seen as a rather crude measure, it is clear from Table 2 that we have witnessed huge fluctuations in the license valuations of these operators during the year 2000. In fact, analysts were estimating 400-600 Euros per capita from the Swiss auction (the last of the auctions included in Table 2) as late as one week prior to this auction. Thus, as an allocation mechanism, auctions seem to be fraught with volatility even though the observed fluctuations could possibly also be explained as a high systematic elasticity of the auction outcome to variations in auction design (see Klemperer 2001).

2.2 Technological scale economies and product versions

The core industries in the information economy exhibit very strong economies of scale so that the costs are predominantly of a sunk character in the form of 'first-copy costs'. Thus, the marginal costs of producing additional copies are far below average costs. Clearly in the presence of Internet this pattern has been accentuated since Internet makes the costs of physical replication and distribution negligible. This change in the production functions will show up as increased price-cost margins, widening the gap between market equilibrium and social efficiency, at least when evaluated with the traditional static methods familiar from industrial economics.

Accentuated scale economies create strong incentives for firms to design mechanisms, making it possible to exploit the variations among consumers in their willingness to pay. As Varian (1999) has emphasized, by systematically introducing different product versions equipped with different degrees of associated characteristics, the firms can create screening mechanisms for price discrimination based on the consumers' self-selection. For example, the producers of mobile phones have successfully exploited business strategies based on versioning.

2.3 Network externalities

In the presence of network externalities, goods or services are more valuable the higher the number of consumers using them. Thus, through these network effects the information economy is characterized by strong demand-side economies of scale.

Typically, network externalities can be expected to imply highly concentrated industries and thereby to have strong implications for market structure. Similarly, the network effects will impact on firms' conduct, because the equilibrium prices will depend on network size (number of users). For these reasons, the network externalities will strongly affect competition dynamics. Network externalities create switching costs and lock-in effects, whereby an incumbent firm—as soon as it has accumulated a sufficiently extensive consumer base, the critical mass—is able to expand its market shares without necessarily being more efficient than its competitors. As a strategic implication one can expect the network industries to generate a race for achieving the critical mass. Investments made in order to achieve the critical mass will generate a long-term return based on the fact that having achieved such a critical mass, these firms can sustain a price-cost marginal which is protected from competition by a barrier represented by the switching costs.

In the presence of network effects, innovation-intense Schumpeterian competition tends to generate an intertemporal pattern of technological leaders. The leaders temporarily enjoy huge market shares until dominance is overtaken by superior technology leapfrogging the current leader. This phenomenon can be illustrated by observations from the software industry. In 1990 Word Perfect was estimated to have a market share of 50 per cent, while Microsoft Word had 10 per cent. By 1997 the picture had changed radically. By this time Microsoft Word had achieved the dominant position with a market share of almost 95 per cent, while Word Perfect had crashed to less than 5 per cent. Spreadsheets offer another example. Lotus 1-2-3 enjoyed a 70 per cent market share in 1988, while that of Microsoft Excel was approximately 10 per cent. Again, by

1997 the role of these competitors had reversed, with Microsoft Excel holding a market share of 90 per cent, while Lotus 1-2-3 had below 10 per cent.

2.4 Complementarity between system components

Electronic devices, such as computers, are composed of components that form systems. But not until the modern type of information economy have so many complementary products been so tightly bound up through interfaces. As a result, firms spend huge resources forming strategic alliances, setting standards and collaborating with partners to make sure that their products work together effectively to comprise a competitive overall system.

Systematic bundling of complementary products is a business strategy frequently observed in the information economy. Due to complementarities between included components, the strategic advantages may increase as a function of the size of the bundle. Such bundling advantages may be one explanation as to why Microsoft achieved dominance in the Office software suite despite the existence of well-established rivals in each component.

Nalebuff (2000) offers a theoretical model capturing the strategic advantages of bundling within the framework of an industry characterized by actual or potential competition. While it is not surprising that bundling leads to higher profits, Nalebuff (2000) demonstrates a mechanism based on external effects as to why consumers also may benefit from product bundles when there is a complementary relationship between the components. Thus, in the presence of sufficiently strong complementarities, concentration-enhancing bundling could promote efficiency.

So far we have outlined a number of characteristic features of the core industries in the new information economy. In the last subsection we briefly present one vision of how to accurately model competition in an industry with all the features delineated above.

2.5 A real options approach to timing competition

For firms operating in the innovation-intensive core industries of the new information economy, the timing for the implementation of irreversible investments—like the adoption of new technologies—represents a crucial strategic instrument, the importance of which is emphasized through the presence of network effects. Typically these types of irreversible investments are made in the presence of a substantial degree of uncertainty. This can be exemplified by the European telecommunication industry. This industry is in the process of investing more than US$ 300 billion over the next three or four years with the intention of bringing together the two hottest technologies of the moment, the mobile phone and the Internet, in the form of third-generation (3G) UMTS-networks. This highly risky investment is split, more or less evenly, between money paid to the governments for the spectrum licenses and investments for building new broadband networks to transport data at high speed. Platform investments, like Internet portals with the objective of creating a network for efficient, low-cost access to customers, offer still another example of a similar type of investment characterized by irreversibility and uncertainty. Such a platform investment can be viewed as the acquisition of a set of strategic entry options.

In a world characterized by uncertainty, new technology adoption can be viewed as a decision whereby the stochastic process generating a firm's cash flow is transformed from one process to another. Within such a framework the optimal adoption timing can be characterized by applying the real options approach familiar from modern investment theory. However, the real options literature has typically been restricted to two very specific assumptions: (i) the representative firm has a monopoly with respect to an investment opportunity and (ii) the underlying product market is perfectly competitive. As a result, the investment affects neither prices nor market structure.

In order to make the real options approach particularly useful as a way of modelling competition in the new economy, it needs to be generalized in two important dimensions. Firstly, in order to analyse industries in which firms in possession of market power compete with each other, we ought to incorporate imperfect competition so that there is strategic interaction between the adoption decision of the competing firms. Secondly, in order to capture system complementarity and network effects, we should incorporate the benefits of adopting new technology when competitors also do so. Within such a framework one could ask the following questions: What type of adoption pattern will be generated through competition? What is the relationship between the adoption equilibrium, the stochastic properties of the incumbent and new technologies in terms of, for example, the drift rate and the volatility if the technologies are represented as geometric Brownian motions, and the market structure? How will network effects, uncertainty and strategic pre-emption incentives interact? Under what circumstances will there be a role for government intervention in the form adoption policies? The real options approach recently applied in Alvarez and Stenbacka (2001a and 2001b) probably serves as a useful analytical basis for such a research programme.

3 Competition policy in the information economy

In general, vertical or horizontal integration tends to be pro-competitive as long as decisions of the firms are strategic complements to markets with imperfect competition. Further, mergers or strategic alliances can be expected to promote innovation activities that make use of complementary system components to create new products or new value-creating combinations of existing system components. In this respect, increased concentration tends to enhance the innovation performance of industries. On the other hand, increased concentration enables firms to exploit bundling strategies in order to extract the increased willingness of consumers to pay for more integrated bundles of products or services.

In particular, the presence of network externalities makes it possible for a firm to achieve a dominant market position, in the sense of antitrust legislation, at a lower market share than what would be the case in a 'traditional' industry. Similarly, a firm possessing a dominant market position and operating in a network industry has access to a larger number as well as more efficient strategic instruments in order to abuse its dominant market position relative to a firm operating in a traditional industry. For that reason, structural microeconomic policies in the form of competition policy and antitrust legislation can be regarded to have potentially a higher social rate of return when applied within the innovation-intensive core industries of the information economy than within the traditional industries. As a consequence thereof, the potential

gains from these microeconomic policies can be expected to increase relative to those associated with macroeconomic policies.

The implementation of competition policy, however, might be more difficult in the core information industries than in the traditional industries. In the new economy, competition policy concepts and instruments need to be modified so as to fit not only the traditional and static views of competition, but also the dynamic features of competition in the high-tech network industries, as emphasized by Ahlborn, Evans and Padilla (2000).

Competition laws in modern economies, exemplified by Article 86 of the EC Treaty (the Treaty of Rome), typically prohibit any abuse of dominant market power. Thus, the documentation of market dominance constitutes a necessary condition for competition policy interventions. Market dominance, in turn, has to be verified in relationship to a well-defined relevant market.

As for the definition of a relevant market, the implementation of competition law typically pays attention to three main features: demand substitutability, supply substitutability and potential competition. Along these three dimensions, the emergence of high-tech network industries tends to shift the emphasis from demand substitutability towards uncertain potential competition from future generations of superior products.

The Schumpeterian nature of the industry dynamics in the high-tech network industries will by necessity imply high industry concentration. When evaluating market dominance, present market shares should obviously be discounted as measures of market power insofar as potential future entry serves to constrain the conduct of incumbent firms with large market shares. Such a view seems to be in line with last year's court decision in the highly visible Microsoft case. This court decision dictates a horizontal division of Microsoft's activities so that the operating systems are separated from the production of software applications. As a justification for its decision the Court considered the current dominant market position of Microsoft as discouraging innovation and technological progress in the industry, but the court did not refer to any abuse of dominant market position in the form of pricing conduct.

3.1 Competition policy: challenges ahead

Monopoly tends to be good for the owners, but bad for the consumers. Common wisdom among economists further suggests that the negative impact on consumers tends to dominate relative to the positive profit effects associated with monopolization. This divergence explains, in a nutshell, why governments employ antitrust policies.

However, technological progress, network externalities and international competition all represent disturbances relative to the common wisdom outlined above. With the innovation-intense competition typical for the information economy, innovation is increasingly driven by firms that win temporary monopoly power, but enjoy it only for a moment before being replaced by a company with a better product which also gains a short-lived monopoly position. This suggests that the information economy may feature more monopolies than the traditional sectors of the economy, but that these monopolies may harm consumers only for a limited period of time. Indeed, if these market dynamics encourage innovation, consumers might actually benefit from the dynamic efficiency

generated by high market concentration. Analogously, the presence of network externalities offers additional strategic instruments whereby incumbent firms might be able to abuse dominant market positions. Finally, the presence of export revenues in imperfectly competitive international markets, in turn, means a shift in the trade-off between consumer and producer interests.

Future research on competition policy should attach particular priority to the general characterizations of optimal national competition policy as well as its implementation in the presence of endogenous technological progress, network effects and international competition. The existing literature has typically addressed competition policy issues in the absence of network externalities and in the absence of international trade. Access pricing is a good example of a policy that promotes competition among firms in industries exhibiting network effects (e.g., telecommunication services). In fact, a large majority of the antitrust cases that have during the past few years reached the Competition Council in Finland, for example, focus on firms operating in network industries.

There are strong reasons why future policy-related research in this field should pay particular attention to the implementation issues. How should access pricing be designed and what should the relationship be between regulatory authorities and competition authorities when it comes to network industries? What is generally the optimal design of the competition-promoting agency, i.e. what objectives given to the competition authorities represent an optimal form of strategic delegation? How can competition authorities overcome the barriers created by asymmetric information in relationship to the firms? How can leniency programmes, for example, be exploited to induce self-reporting on behalf of cartel members?

The importance of precisely identifying the objective(s) which competition policy is supposed to achieve is emphasized by the characteristics of the information economy. Namely, the information economy is likely to magnify the conflict between consumer welfare, on the one hand, and plausible alternative objectives such as fairness relative to competitors or the promotion of small- and medium-sized enterprises, on the other hand. Namely, the combination of economies of scale on the supply side and network effects on the demand side tends to make concentrated markets consistent with efficiency, and mechanical attempts to keep the market artificially fragmented are likely to damage not only the industry, but also the consumers. In spite of the tendency for single firms to dominate high-tech industries, these firms are unable to persistently sustain monopoly positions, either by raising prices or by failing to innovate. Lurking behind every corner are potential threats to dominance. In fact, the recent history of high-tech industries offers many examples of once-dominant firms that have failed to run hard enough to defend their dominance—McDonnell-Douglas, Polaroid and Silicon Graphics to name a few examples.

3.2 Supranational versus national competition policy

The basic trade-off that countries face in constructing their competition policies is that between firm profits and consumer welfare. However, if the consumers affected by the collusion are not citizens, this trade-off disappears since firms are exporters and competition policy is guided by the search for export profits. Thus, in the presence of international trade, competition policies implemented on a national level will mean that

countries impose substantial external effects on each other. Consequently, increased international economic integration enhances the benefits from international coordination of competition policies. Thus, in Europe, the European Commission plays an increasingly important role as a coordinating supranational institution for competition policy and antitrust implementation. For example, the number of mergers reported to the European Commission has increased to almost 350 cases per year.

However, centralizing competition policy to a supranational institution like the European Commission causes a number of problems, as exemplified by the recent blocked merger planned between the two Swedish motor vehicle makers, Volvo and Scania. The Volvo-Scania case brought into daylight the question of whether small countries, like the Nordic ones, are at a disadvantage if the Commission's definition of market dominance automatically refers to fairly small and segmented national markets rather than to the European market in a broader sense.

In light of the ongoing worldwide process of globalization, whereby an increasing share of all national economies are exposed to international competition, the following questions have very high priority: Is it optimal from a global perspective to centralize the conduct of competition policy to a supranational institution? How should supranational competition policy be conducted? When are there reasons to delegate competition policy to national authorities?

4 Technology policy in the information economy

4.1 Innovation policies

Intellectual property rights constitute the heart of the new information economy. Innovation-enhancing technology policies can broadly be classified into two types: subsidies and patents (copyrights) and standards. Subsidies represent an *ex ante* commitment on behalf of the government to share a part of the risks associated with investments into innovation. In contrast, patents represent an *ex post* reward directed towards successful innovations with no *ex ante* risk sharing.

Following Denicolo (1996), for example, optimal patent policy can generally be summarized by the following principle. If the marginal rate of substitution of patent life for breadth is larger (smaller) on the incentive to innovate than on social welfare, the optimal patent policy is characterized by maximum (minimum) breadth and minimum (maximum) length. However, presently the pace at which generations of successively improved technologies replace each other seems to be so fast in many of the central areas of the information economy, like in the software industry, that it renders the patent instrument fairly irrelevant. In these industries firms obviously have very limited incentives to employ the patent instrument in the first place. In fact, Shy and Thisse (1999) formalize this idea by focusing on the strategic reasons for oligopoly firms to drop software protection. Within the context of a differentiated software industry, they demonstrate that unprotecting is an equilibrium for a noncooperative industry under sufficiently strong network effects. Thus, Shy and Thisse offer a plausible strategic reason based on the importance of the degree of network externalities prevailing in the industry as to why the use of software protection has declined since the mid-1980s.

Bessen and Maskin (1999) address the issue of why industries such as software, semiconductors and computers have been so innovative despite historically weak patent protection. They actually build a formal model, which shows that patent protection may in fact reduce overall innovation and social welfare if there are sequential generations of technology and if the innovation activities are complementary. The central analytical feature of the model by Bessen and Maskin can be captured by the following intertemporal effect. Although imitation reduces the innovator's current profit, it raises the probability of further innovation and thereby strengthens the incentives for future innovations.

Should the technologies underlying the new information economy, like IT-investments, be subsidized? In principle, these technologies constitute a natural candidate for subsidy policies, as they are associated with external effects and in many cases they are examples of multi-purpose technologies. However, the successful design of a subsidy policy requires from the policymaker knowledge and accurate assessments of the future technological development. There are strong reasons to believe that the firms active in these markets are better equipped to make these assessments than bureaucrats or politicians.

Empirical evidence indicates that the technology of a country typically tends to be distorted towards those production factors in which it is well endowed. For example, countries well endowed with qualified human capital tend to adopt production technologies that match the high qualifications of human capital (see, for example, Caselli and Coleman 2000). Thus, an emphasis on the accumulation of human capital can contribute to a fast and successful development of the IT-industry. But, in principle, there seems to be no fundamental reason as to why market mechanisms would not be able to achieve—or to achieve with less success than politically administered solutions—the allocation of human capital consistent with growth of the high-tech industries.

4.2 Adoption and imitation policies

In the early 1990s many participants in the American policy debate (for example, Branscomb 1992) forcefully argued that a technology policy which is restricted to supporting the creation of new technologies is not sufficient. Instead, it was argued, emphasis should additionally be placed on stimulating demand for new technology by helping industrial companies across the industrial spectrum to speed up the commercialization of new ideas to meet specific business needs. For example, the technology policies behind the success of the Japanese consumption electronics industry were founded on a priority that supported efficient adoption of existing technologies rather than towards the creation of new technologies (e.g., the adoption of high-definition television, HDTV, in the early 1990s).

In a recent study of Asian countries, Wong (2001) finds that the more advanced Asian countries (Japan and the four Asian NIEs) as a group achieved above-norm ICT diffusion intensities, while the six less developed Asian nations significantly underperformed relative to their level of economic development and competitiveness. Thus, the less advanced Asian countries seem to have over-emphasized industrial policy in favour of electronics manufacturing at the expense of promoting adoption of ICT in the economy as a whole, particularly the service sectors. These observations may

suggest that the human capital bottleneck might place a severe restriction on how fast new technologies can be diffused in the late-industrializing countries despite the possibilities of free-riding on the experience accumulated in innovating countries.

In many high-tech industries the ability to imitate requires conscious investments and long-term developments of a knowledge stock. In such industries the knowledge spillovers and thereby endogenous diffusion of technology are the consequences of rational investments into imitation. Kanniainen and Stenbacka (2000) investigate how the presence of such a type of imitation, which no doubt is relevant for high-tech industries, calls for revisions of technology policy. Their analysis identifies circumstances under which the market equilibrium will generate underinvestment in imitation, leading to a suboptimal degree of technology diffusion. Such cases arise, for example, in Cournot industries facing highly price-sensitive demand or in Bertrand industries with modestly differentiated products. Under such conditions the optimal technology policy combination calls for innovation policies to be complemented by imitation-enhancing policies in line with the competition-enhancing policy implications of Bessen and Maskin (1999).

4.3 Standards, compatibility and coordination

The information economy is characterized by frequent networks representing a diverse spectrum of strategic alliances between high-tech firms. Cooperation in the design of compatibility standards is a crucial area of cooperation between high-tech firms, in particular in systems markets. The software industry reports examples where even fierce rivals, such as Microsoft and Netscape, sign up to jointly design compatible standards. What are the implications of cooperative standard setting? Will cooperation generate efficient standards and consumer benefits or does cooperation simply represent a collusion-enhancing mechanism whereby the participating firms could shift benefits from consumers to producers?

We can directly point to two benefits associated with cooperative standard setting. Firstly, to the extent that coordination enhances compatibility through an industrywide standard, consumers will benefit from strengthened network effects. Secondly, standards reduce the technology risks faced by consumers, since the risk of being left stranded with incompatible system components is lowered. However, standardization will also have social costs. Standardization will constrain product variety and possibly limit available paths for innovation intended to create future technology generations. With coordinated standard setting there could also reasonably be an increased risk of cooperation being extended to the product market stage. In order to evaluate the overall consequences of cooperative standard setting, we need to balance all these counteracting effects against each other.

At least the following general conclusion can be drawn. In the presence of compatible standards, firms face lower incentives to innovate because with standards the product market competition tends to be more intense, meaning that the payoff from successful innovation will be lower. Thus, as Shapiro (2000) concludes, standards shift the locus of competition: incompatible systems compete in a dynamic sense *for* the market; compatible-system products compete in a static sense *in* the market. In other words, setting cooperative standards shifts the emphasis from dynamic innovation-oriented competition towards static competition in the product market. Consequently,

evaluations of cooperative standard-setting involve by necessity an intertemporal trade-off, which is shifted more in favour of standards the greater the interest rate factor according to which society discounts future benefits.

5 Some policy-relevant business features in the new information economy

So far the policy implications discussed have been either in the field of competition policy or technology policy. However, a number of core industries in the new information economy are characterized by numerous prevalent business practices with obvious implications from a microeconomic policy perspective. In this section, we focus on three such aspects, namely (i) market transparency, (ii) strategic outsourcing and (iii) the interrelationship between compensation, bargaining and entrepreneurship.

5.1 Market transparency

The revolution in information technology has implications throughout the economy. Information technology can be seen as an infrastructure with the potential to promote economywide efficiency through changes in the microstructure of most markets. In particular, the Internet represents a strong instrument in this respect. The Internet can reduce the search costs faced by consumers and thereby reduce market imperfections throughout the economy. In line with this prediction, a recent empirical study by Brown and Goolsbee (2000) estimates that Internet has reduced term life prices by 8-15 per cent in the American life insurance industry. In this way new technology can also make certain intermediaries redundant, like many of the services offered by travel agents. In addition to these fairly obvious economywide consequences, the Internet is often said to promote efficiency by introducing market transparency.

Transparency has been a buzzword for a long time in consumer protection, in competition policy and in informal evaluations of the consequences of the e-commerce, for example. Improved market transparency is alleged to assist consumers in comparing substitute goods or services and their prices. Seen in isolation, this should intensify competition, and thereby enhance efficiency, by making consumers more sensitive to perceived differences in the mix of price and commodity characteristics. This effect is likely to have positive welfare implications, in particular in fragmented search markets.

However, it seems hard to improve the information to customers without affecting at the same time the information and strategic incentives of firms. *A priori* there are at least two mechanisms whereby firms in oligopolistic industries could benefit from improved market transparency. Firstly, improved transparency enhances the ability of oligopolists to sustain collusion as it enables detection of deviations from a tacitly collusive agreement quicker and with greater precision. Secondly, improved transparency makes it possible for tacitly colluding firms to sustain more severe punishments following a deviation since consumers react more to perceived differences in the mix of price and characteristics across products.

It is an important challenge for research in the near future to carry out an overall evaluation, which incorporates both the efficiency-enhancing effects from better informed consumers and the collusion-promoting effects of more precise information transmission between firms, of the welfare implications of increased transparency.

5.2 Strategic outsourcing

All over the industrialized world, outsourcing has become an increasingly popular method for firms to organize their production in order to achieve competitiveness. This applies in particular to several network industries. Many scattered observations support such a view. Most producers of Laser printers do not make the engines, but buy these instead from Canon, a Japanese manufacturer. Most computer companies outsource a great deal. Whereas the Intel chips are patented (or copyrighted), PC producers have the option of licensing production processes for making clone chips in-house. Thus, the choice to buy chips from Intel can, in effect, be viewed as the outsourcing of a key component. Further, for example, Sun Microsystem is considered to purchase between 75 and 80 per cent of its components from other companies (Domberger 1999). In the telecommunications industry, it has been estimated that Nokia alone makes use of more than three hundred domestic subcontractors in addition to an almost equally high number of foreign subcontractors. Furthermore, casual observations suggest that it has been a common business practice for competing product market firms to outsource production to joint subcontractors, which can be exemplified by Ericsson and Nokia, the competing mobile phone producers.

Even though the contract theory has been instrumental for understanding some important aspects of a firm's outsourcing decisions, the contract theory literature typically has not captured the role of outsourcing in industries where firms compete with their design of organizational production mode as the strategic instrument. However, in a recent study, Shy and Stenbacka (2001) construct a model of firms using their design of organizational production mode as a strategic instrument. They investigate how the market structure of an input-producing industry will affect production efficiency in a differentiated and imperfectly competitive final goods market. Shy and Stenbacka demonstrate how introduction of competition among input suppliers will achieve the double goal of making components available at average cost without sacrificing the ability to exploit economies of scale, because in a subgame perfect equilibrium firms will delegate production to a joint subcontractor. As this feature is shown to be a robust outcome in several respects, we can conclude that outsourcing seems to promote efficiency in imperfectly competitive industries. In this respect the current trend of an increased degree of outsourcing should be welcomed by industrial economists concerned not only with industry profits, but also with social efficiency.

This brief discussion of the firms' choice of organizational production mode has been restricted to those of vertical integration (in-house production) or outsourcing. Of course, in reality there is a full spectrum of additional organizational forms, like the formation of joint ventures, available to firms. For an overview of existing studies of the strategic incentives to form research joint ventures, we refer to Poyago-Theotoky (1997). For more general approaches to analyse the interactions between asymmetric information, divergence of objectives and the governance of joint ventures, we refer to Aghion and Tirole (1994) and Rey and Tirole (1999).

5.3 Compensation, bargaining and entrepreneurship when human capital is a scarce resource

Side by side with the strongest bull market ever in the stock markets climaxing throughout the western world during the first half of year 2000, we have witnessed a hitherto unexperienced increase, both in an absolute and in a relative sense, in compensations paid to top executives and key personnel. For example, the main American federation of trade unions has estimated that, thanks largely to stock options, the average American chief executive in 1999 earns 419 times the wage of the average factory worker. This ratio should be compared to the fact that in 1980 such an executive made 42 times as much as the average factory worker. In particular, stock-option programmes have grown at a breathtaking pace. *The Economist* (1999) reports that the 200 largest American companies granted shares and share options to employees amounting to 2 per cent of their outstanding equity during the year ending June 1998. When added to incentive programmes made in previous years, it was estimated that the accumulated value of the incentive schemes in effect at the end of 1998 amounted to as much as 13.2 per cent of the corporate equity of these firms. While there has also been an increase in the value of stock options granted to lower-ranking employees, most of the value incorporated in these incentive schemes is concentrated in 'mega-options' directed to a fairly small number of top executives.

Many firms operating in the dynamic high-tech industries face an increasingly demanding challenge in how to recruit the most promising human capital or how to keep their key personnel. Partly this might reflect an increasing relative importance of human capital compared with traditional capital investments, an aspect that might very well be exemplified by industries like those of IT-consulting, Internet services and e-commerce. In fact, Rajan and Zingales (2000) offer a number of convincing arguments why the importance of a firm's human capital, as represented by its employees, has increased. These industries also serve as examples of industries where key personnel are offered very lucrative compensation schemes. In particular, rival firms are engaged in competition not only for the traditional product markets, but also for qualified human capital equipped with bargaining power.

Partly the intensified battle for talent might also be significantly related to the structural changes, which have taken place in the financial markets. In particular, the development of the markets for outside equity, which could be exemplified by the dramatic growth from the mid-1970s of the venture capital industry, has opened new opportunities for entrepreneurship and start-ups for high-quality employees with new business ideas. Thus, for key personnel equipped with potentially profitable business ideas and with bargaining power relative to their employers, the large mass of investors with preferences to invest in start-ups either directly or intermediated through funds, represents an outside option which will presumably affect negotiations regarding compensation contracts. In other words, a well-performing market for outside equity might offer career options against which established firms have to defend themselves by designing very lucrative compensation contracts in order to avoid small start-ups that skim off talented employees. The still overheated markets for productive workers in IT-consulting, Internet services and e-commerce offer examples of industries where this might be a plausible mechanism for understanding the compensation contracts observed.

A recent study by Koskela and Stenbacka (2000) has its focus on the interrelationship between bargaining power, entrepreneurship as an outside option and compensation contracts. The authors concentrate on contract negotiations where not only the principal, but also the agent possesses bargaining power. Secondly, the analysis is carried out in a framework where the agent's individual rationality constraint is not considered to be an exogenous feature as in standard models of wage bargaining. Instead, entrepreneurship represents the outside option available to the agent in his negotiations. In other words, the outside option of the agent is to start up as an entrepreneur pursuing a business idea closely related to the project he performs within the employment relationship. Within such a context the approach by Koskela and Stenbacka (2000) offers characterizations answering the following questions: Under such circumstances, how will shifts in technology towards production functions with greater emphasis on human capital affect negotiated compensation contracts? Can the dramatic increase in the compensation directed to top executives and key personnel be explained by reduced imperfections in the market for outside equity? And, if so, how precisely does the mechanism whereby the market for human capital is tied to the competitiveness of the capital market operate? Altogether this approach offers a characterization of how the competitiveness of the capital market will impact on the imperfections in the labour market in an environment where these imperfections are not based on bargaining power in the traditional sense of union bargaining models, but rather on specialized non-alienable human capital.

With an increasing relative importance of non-alienable human capital, the significance of the interaction between financial institutions and corporate governance will increase in the new economy, as emphasized by Mayer (2001). In particular, the new economy will pose challenges for the joint design of financial claims and control rights so as to encourage entrepreneurial initiative in the sense of Aghion and Tirole (1997).

6 Concluding comments

In this article we have emphasized innovation-intensive competition, strong technological scale economies, network effects and complementarity between system components as characteristic features of the core industries in the information economy. In particular, the combination of strong technological scale economies on the supply side and network effects on the demand side makes market structures with high concentration and dominant firms both likely and efficient. On the other hand, a firm possessing a dominant market position and operating in a network industry has access to a more efficient set of instruments to abuse its dominant market position relative to a firm operating in a traditional industry. Recognition of these two counteracting aspects forms a necessary condition for the design of successful competition policy in contemporary high-tech markets.

In light of the industry characteristics of the new economy industries, competition authorities should maintain a high threshold of convincing themselves that a business practice is, in fact, harmful (with reference to a well-justified time horizon) to consumers, before judging the business practice in question illegal. Ideally, convincing evidence should rely on consistent theoretical arguments as well as industry-specific empirical data. Due to the Schumpeterian nature of the innovation-intensive competition in high-tech industries, the successful acquisition of a dominant market position

typically occurs at the expense of rivals. Of course, rivals losing in the innovation race will typically be keen to raise complaints to antitrust authorities for anticompetitive behaviour against technology winners. In facing such complaints, it is crucial for competition authorities to distinguish between policies that protect competition from those that protect competitors. Efficient competition policy is founded on the protection of competition, not competitors.

In the presence of scale economies, efficient competition policy has always had to face a structural trade-off between the exploitation of such scale economies and the promotion of entry and small enterprises. In light of the characteristics of its core industries, this trade-off is shifted towards more concentrated industry structures in the information economy, because of stronger technological scale economics as well as network effects. Or equivalently, the disadvantages in terms of efficiency from the artificial promotion of fragmented industry structures are stronger in the information economy than in traditional industries. Despite such a shift in the trade-off between the exploitation of scale economies and the promotion of entry and small enterprises, it should, nevertheless, be emphasized once again that the characteristics of a network industry yield access to an extended set of sharp instruments for abusing dominant market positions.

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