COMPETITION POLICY FOR THE NEW ECONOMY

by

Federico Etro[♣]

The New Economy, characterized by dynamic, global and innovative markets, requires a new way to approach many economic issues and also a new way to approach competition policy. This work will analyze an approach toward competition policy based on recent progress in the theory of market leaders and discuss its implications with special reference to markets of the New Economy, whose distinctive features, namely high fixed costs of R&D, less relevant marginal costs of production and network effects, require different analysis from traditional markets. Close attention will be given to the software market, that has been (and still is) the subject of the attention of antitrust authorities around the world. For a more comprehensive discussion on these theoretical and applied issues see Etro (2007).

The scope of antitrust policy is to avoid distortions of competition that may negatively affect consumers, as collusive arrangements aimed at fixing prices above their competitive level, mergers aimed at creating a dominant positions, and abuse of dominance by market leaders against the interests of consumers. Our attention will be on this last aspect of antitrust policy: abuse of dominance with anticompetitive purposes.

In the United States the main federal antitrust statute is the Sherman Act of 1890, which was developed in reaction to the widespread growth of large scale business trusts. The current interpretation of US antitrust law associates abusive conduct with predatory or anticompetitive actions having the specific intent to acquire, preserve or enhance monopoly

♣ University of Milan, Dept. of Economics, Intertic and ECG (federico.etro@unimib.it). I am grateful to Yannis Katsoulacos, Vincenzo Denicolò, Massimo Motta, Patrick Rey, Damien Geradin, Robert O'Donoghue, Lia Athanasiou, Kai-Uwe Kuhn, Kamil Kiljanski and the other participants to the CRESSE Conference on the Abuse of Dominance and to the Round Table on the reform of Art. 82 for interesting discussion on these topics, both held in Corfù (July 14-15, 2006).

power distinguished from acquisition through a superior product, business acumen or historical accident (hence monopoly per se is not illegal). It is generally accepted that an action is anticompetitive when it harms consumers. In Europe competition policy has a more recent history which is mostly associated with the creation of the European Union and its coordination of policies for the promotion of free competition in the internal market. The main provisions of European Competition Law concerning abuse of dominance are contained in the Art. 82 of the Treaty of the European Communities. The application of EU competition law on abuse of dominance involves the finding of a dominant position and of an abusive behaviour of the dominant firm, usually associated with exploitative practices as excessive pricing,[1] and with exclusionary practices as predatory pricing, rebates, tying or bundling, exclusive dealing or refusal to supply. However, the analysis of both dominance and abusive behaviours entails complex economic considerations and its reform in the EU is the subject of an on going debate.

Many economists have pointed out the necessity of a closer focus on consumer welfare in the implementation of competition policy with specific reference to abuses of dominance. While antitrust legislation was written with this objective in mind, its concrete application has sometimes been biased against market leaders and in defense of their competitors rather than toward the defense of competition and of the interests of consumers. The two objectives do not necessarily overlap. The development of the New Economy, characterized by very dynamic and innovative markets, has increased the pressure for a new approach, already somewhat developed in the United States, but just in progress in Europe. A EU Report by Rey et al. (2005) has recently argued in favour of an effects-based approach to competition policy, which associates abuses of dominant positions with anti-competitive strategies that harm consumers.

In line with this proposal, we believe that a new approach to competition policy should be based on rigorous economic analysis, from both a theoretical and an empirical point of view. Rey et al. (2005) emphasize this element in the antitrust procedure: "a natural process would consist of asking the competition authority to first identify a consistent story of competitive harm, identifying the economic theory or theories on which the story is based, as well as the facts which support the theory as opposed to competing theories. Next, the firm should have the opportunity to present its defense, presumably to provide a counter-story indicating that

[1] On this point see Katsoulacos (2006).

the practice in question is not anticompetitive, but is in fact a legitimate, perhaps even pro-competitive business practice." Moreover, any theory of the market structure able to provide guidance in detecting abuses of dominant positions should take into account the role and the strategies of market leaders, describe the equilibrium outcomes in function of the entry conditions and of demand and supply conditions, and provide welfare comparisons under alternative set-ups.

In this article we will try to argue that, while the Chicago school and the post-Chicago approach had problems in providing a unified framework which matches these requirements, the theory of market leaders, surveyed in Etro (2007), has provided alternative insights that may be useful for this purpose. The general principle is that market leaders may behave in an anti-competitive way, accommodating or predatory, in markets where the number of firms is exogenous (meaning that outsiders cannot overcome barriers to entry even when there are profitable opportunities in the market), while they always behave in an aggressive way when entry into the market is endogenous (meaning that it depends on the profit opportunities in the market). In the first situation a large market share of the leader can be the fruit of anti-competitive strategies, but in the second situation, a large market share of the market leader is a consequence of its aggressive strategies and of the entry conditions, and not of its market power. Hence, there should be no presumption of a positive association between market shares and market power unless the lack of free entry conditions has been established.

This has a main implication: while the old approach to abuses of dominant positions needs to verify dominance through structural indicators and the existence of a certain abusive behaviour, a new economic approach would just need to verify the existence of harm to consumers. As Rey et al. (2005) correctly point out, "the case law tradition of having separate assessments of dominance and of abusiveness of behaviour simplifies procedures, but this simplification involves a loss of precision in the implementation of the legal norm. The structural indicators which traditionally serve as proxies for `dominance' provide an appropriate measure of power in some markets, but not in others", in particular not in markets where entry is an important factor (a concentration index is uniquely concerned with actual competition and ignores potential competition) and when innovation is important (a concentration index can deal with competition in the market, not for the market).

1. THE TRADITIONAL APPROACHES TO ABUSE OF DOMINANCE

In this section we are going to review some aspects of the traditional approaches to antitrust policy on abuse of dominance and start comparing them with the insights of the recent theoretical attempts to build a comprehensive theory of market leadership and competition policy. In our view, a full fledged model of the behaviour of market leaders is a necessary toolkit for deriving implications for abuse of dominance.

The traditional *"pre-Chicago" approach* was mostly based on basic models of imperfect competition associating market power, high market shares and abusive conduct with the typical behaviour of monopolists. Such a naïve view has been challenged in the 60s and 70s by the *Chicago School* whose main merit has been to show that, when there are potential entrants in a given sector, aggressive strategies that would be suspect, such as bundling, price discrimination and exclusive dealing, are not necessarily anti-competitive but may instead have a strong efficiency rationale (for a classic work by the leading scholar of the Chicago school see Posner, 1976).

More recent theories, often associated with the so-called "*post-Chicago" approach*, have however shown that in the presence of pervasive market imperfections, the above strategies can be anti-competitive because they are aimed at deterring entry in the short run and protect monopolistic rents in the long run. Broadly speaking, US antitrust authorities have been highly influenced by all these approaches over time, while it is hard to claim that the same is true of the EU antitrust authorities.

We believe that these traditional approaches gave important insights into many antitrust issues, but they failed to provide a complete understanding of the behaviour of market leaders. The Chicago approach limited most of its analysis to either monopolistic or perfectly competitive markets, and in a few cases, to markets characterized by a monopolist and a competitive fringe of potential entrants. For instance, according to the Chicago school there is not such a thing as predatory pricing, that is reducing prices below costs to induce exit by the competitors so as to compensate the initial losses with future profits: if the incumbent can sustain such initial losses, also any other competitor can do it as long as credit markets are properly working, hence predatory pricing would not be effective to start with. This approach failed to provide results that were robust enough to withstand full-fledged game-theoretical analysis of dynamic competition between incumbents and entrants.

In the 80s and 90s, post-Chicago research studied more complex market structures within a solid game-theoretic framework and introduced welfare considerations so as to derive sound normative implications, which represents one of the main contributions of this approach. For instance, with reference to predatory pricing, the post-Chicago approach has shown that in the presence of asymmetric information between firms, of credit market imperfections and of strategic commitments to undertake preliminary investments, the above argument breaks down and predatory pricing can be an equilibrium strategy for the incumbent and deter entry. However, in most cases, this literature studied the behaviour of incumbent monopolists facing a single potential entrant. To cite the most known theoretical works with strong relevance for antitrust issues, this was the case of the Dixit (1980) model of entry deterrence, of the models by Kreps and Wilson and Milgrom and Roberts of predatory pricing, of those by Fudenberg and Tirole (1984) of strategic investment, of the Bonanno and Vickers model of vertical restraints, of the Whinston (1990) model of bundling for entry deterrence purposes, of the model by Brander and Lewis on strategic debt financing, and of many other works, often based on analysis of Stackelberg duopolies (that is, markets with one leader and one follower): see Motta (2004) and Whinston (2006) for surveys. Also most of the standard results on the behaviour of incumbents in terms of pricing, R&D investments, quality choices, and vertical and horizontal differentiation are derived in models of Stackelberg duopoly, where the incumbent chooses its own strategies in competition with a single entrant. While this analysis simplifies the interaction between incumbents and competitors, it can be highly misleading, since it assumes away the possibility of endogenous entry, and hence limits its relevance to situations where the incumbent already has an exogenous amount of market power.

It is not surprising that the results of the post-Chicago approach are often biased toward an anti-competitive role of the incumbents: these engage in aggressive pricing, threaten or undertake overinvestments in complementary markets, patent new technologies only to preempt entry, impose exclusive dealing contracts, or bundle their goods with the sole purpose of deterring entry of the competitor. Otherwise they engage in accommodating pricing, underinvest in product improvements and differentiation, and stifle innovation. In such a simple world, what antitrust authorities should do is unambiguously fight against incumbents: punish their aggressive pricing strategies as predatory, and their accommodating pricing strategies as well (but in this case as exploitative strategies), punish investments in

complementary markets as attempts to monopolize them, weaken their IPRs, forbid bundling strategies, and so on. The bottom line is that, according to this view, antitrust authorities should sanction virtually all behaviours of the incumbents which do not conform to those of their competitors.

The fallacy of this line of thought, in our view, derives from a simple fact: it is based on a partial theory which does not take into account that, at least in most cases, entry by competitors is not an exogenous fact, but an endogenous choice. Whether entry is more or less costly, it is typically the fruit of an endogenous decision by the potential competitors (except for cases of natural monopoly or legal barriers to entry, which should not be a subject of antitrust analysis, but of regulatory one), especially in markets that are global by nature. The industrial organization literature has emphasized two different kinds of constraints on entry. The definition of barriers to entry has been quite debated in the literature. Bain associated them with the situation in which established firms can elevate their selling prices above minimal average costs of production without inducing entry in the long run, Stigler with costs of production which must be borne by firms seeking to enter an industry but not borne by the incumbents. A similar approach has been prevailing more, so that we can talk of barriers to entry as sunk costs of entry for the competitors which are above the corresponding costs of the incumbent (or have been already paid by the incumbent). On the contrary, simple fixed costs of entry are equally faced by the incumbent and the followers to produce in the market, but they also constrain entry. Actually, while there is a fundamental difference between the two concepts, their role in constraining entry, and hence in endogenizing it, is basically the same. Only a comprehensive understanding of the behaviour of incumbents when entry is endogenous and when it is not can provide the required tools to judge real world markets.

2. THE THEORY OF MARKET LEADERS

The theory of market leaders (see for instance Etro, 2004, 2006a, 2008) clarifies the role of market leaders and of the entry conditions in a more general framework than that of the post-Chicago approach. In this section we will review its results and compare its implications for antitrust with those of the traditional approach.[2]

[2] See Etro (2006b) for further discussion.

The main point emerging from our analysis of the behaviour of market leaders facing or not facing free entry is that standard measures of the concentration of a market have no relation with its competitive structure and may lead to misleading welfare comparisons.

This outcome is quite clear in the simplest environment one can think of, that of competition in quantities with homogenous goods, constant marginal costs and a fixed cost of production. Such a simple structure approximates the situation in many sectors where product differentiation is not very important but there are high costs to starting production (this is typical of energy and telecommunication industries and some high-tech sectors). In such a market the characterization of the equilibrium market structure is drastically different when entry conditions change. First of all, as long as the number of firms is exogenously given and the fixed costs of production are not too high, the incumbent firm is aggressive but leaves space for other firms to be active in the market. As external observers, we would look at this as a market characterized by a leader with a market share typically larger than its rivals (at least when outputs of different firms are regarded as strategic substitutes), but with a certain number of competitors whose supply of goods reduces the equilibrium market price. The higher the number of these competitors, the lower the price will be; in such a case, lower concentration would be associated with a higher welfare as well.

Radical changes occur when entry in the market is endogenous, and is determined by the profitable opportunities in the market. In such a case the leader would expand production until no one of the potential entrants has incentives to supply its goods in the market. The intuition for this extremely aggressive behaviour of market leaders is simple. When entry is endogenous, the leader understands that a low production creates a large space for entry in the market while a high production reduces entry opportunities. More precisely, knowing how technological constraints govern the incentives to enter in the industry, the leader is aware that its output exactly crowds out the output of the competitors leaving unchanged the aggregate supply and hence the equilibrium price. However, taking this equilibrium price for the market as a given, the leader can increase its profits by increasing its output and reducing the average costs of production. Here the fixed costs of production (associated with constant marginal costs) are crucial: on one side they constrain the profitability of entry, while on the other side they create scale economies in the production process that can be exploited by the leader through an expansion of its output. Actually, it is always optimal for the leader to produce enough to crowd out all output by the competitors: exploiting the economies of scale

over the entire market allows the leader to enjoy positive profits even if no entrant could obtain positive profits in this market. As external observers, in this case, we would just see a single firm obtaining positive profits in a market where no one else enters, and, following traditional paradigms, we could associate this situation with a monopolistic environment, or at least with a dominant position derived by some barriers to entry. But this association is not correct, since entry is indeed free in this market: it was actually the competitive pressure of the potential entrants that induced the leader to produce so much that the equilibrium price is driven down.

Let us consider now a related situation with a different cost pattern for the firms. When marginal costs are substantially increasing in the production level or, more generally, when the average costs have a U-shape, a market leader facing endogenous entry of competitors may not have incentives to deter entry, but would still behave in an aggressive way. In such a case, given the strategy of the leader, all the entrants maximize their own profits and hence price above the marginal cost, but endogenous entry reduces the equilibrium price at a level that is just high enough to cover the fixed costs of production. Notice that this equilibrium generates a production below the efficient scale (which should equate marginal and average costs). Also in this case, the leader takes into account these elements and, in particular, takes as given the equilibrium price emerging from the endogenous entry of the competitors. As a consequence, the leader finds it optimal to produce as much to equate its marginal cost to the price, which requires a production above the efficient scale of production. Since marginal costs are increasing for such a high production level, the leader is pricing above its average cost, and hence obtains positive profits. In this case the strategy of the leader does not even affect the market price, which is fully determined by endogenous entry of firms. Nevertheless, the leader obtains a larger market share than its rivals and positive profits. Moreover, Etro (2002) has shown that the aggressive behaviour of the leader, that adopts a price equal to the marginal cost, improves the allocation of resources compared to the same market with free entry and no leadership. A similar situation emerges when goods are not homogeneous but they differ in quality.

The crucial lesson from this analysis is that we should be careful in drawing any conclusion from indexes of concentration or from the market shares. We have seen examples in which a single firm in the market enjoying positive profits is the equilibrium outcome of a market with free entry, and other examples where the outcome is less drastic but not too different. Notice

that in all these cases, the market leader was adopting extremely aggressive strategies which were reducing entry but increasing welfare nevertheless. Hence, it is also important to notice that strategies that are aimed at reducing entry are not necessarily negative for consumers, especially when entry is not fully deterred, but simply limited due to a low level of the prices, so that some competitors are still active in the market and able to exert a competitive pressure on the leader. Of course, a complete analysis of the consequences of entry deterrence would require a dynamic model taking into account the behaviour of the leader before and after deterrence. Our point here is simply to warn against the risk of directly associating aggressive price strategies that reduce entry with welfare reducing strategies.

Another important implication of the theory of market leaders emerges quite clearly under competition in prices. In this typical situation, the traditional analysis of Stackelberg oligopolies shows that dominant firms are either accommodating (setting high prices) or trying to exclude rivals by setting low enough prices: the first case happens when the fixed costs of entry are small (and predation would be too costly), the second when they are high enough.[3] Such an outcome implies the risk of erroneously associating any aggressive price strategy with an entry deterring strategy. As we have seen, when we endogenize entry in the market, market leaders never adopt accommodating pricing strategies while they are always aggressive. Again, in equilibrium with free entry, leaders increase their market shares and obtain positive profits. Of course an aggressive pricing strategy will still reduce entry, even if it will not exclude all rivals, but we now have to be more careful in associating aggressive pricing with predatory purposes. The reason why predatory strategies are anti-competitive is that they exclude competition in the future allowing the dominant firm to behave in a monopolistic fashion once competitors are out of the market. Of course, if an aggressive pricing strategy is aimed at excluding some but not all competitors, this anti-competitive element is more limited.

The same care in judging aggressive strategies is needed in cases of complementary strategies that virtually induce aggressive behaviours. One of these is bundling. In an influential paper, Whinston (1990) has studied bundling in a market with two goods. The primary good is monopolized by one firm, which competes with a single rival in the market for the secondary good. Under price competition in the secondary market, the monopolist

[3] Accommodating high prices are chosen by the leader when fixed costs of entry are small. The problem is that this is exactly when there are incentives for other firms to enter, hence the duopolistic equilibrium is quite weak, and the study of endogenous entry becomes crucial.

becomes more aggressive in its price choice in case of bundling of its two goods. Since a more aggressive strategy leads to lower prices for both firms as long as both are producing, the only reason why the monopolist may want to bundle its two goods is to deter entry of the rival in the secondary market. This conclusion can be highly misleading because it neglects the possibility of further entry in the market. If the secondary market is characterized by endogenous entry, the monopolist would always like to be aggressive in this market and bundling may be the right way to commit to an aggressive strategy. Bundling would not necessarily deter entry in this case, especially if there is a high degree of product differentiation in the secondary market, but may increase competition in this secondary market and reduce prices with positive effects on the consumers. Notice that the same limit of the analysis of Whinston, namely the exogenous assumption that there are just two firms and further endogenous entry is not taken into account, applies to many other duopoly models of bundling.

In general, the spirit of our result on the aggressive behaviour of leaders goes through when leaders cannot commit to output or price strategies, but can undertake preliminary investments that change their incentives in the market. For instance, a market leader facing an exogenous number of competitors may want to underinvest or overinvest strategically in cost reducing R&D according to the kind of competition (in prices or in quantities), because it may want to commit through these investments to adopt an accommodating or an aggressive strategy in the market: in particular, underinvesting is optimal before price competition, while overinvesting is optimal before quantity competition. However, this ambiguity collapses if the leader is facing endogenous entry of competitors. In such a case, it is always optimal to adopt the strategy that allows one to be aggressive in the market: strategic overinvestment in cost reducing R&D is optimal independently from the form of competition, because it allows one to be aggressive against competitors. A similar role is attached to investment in production capacity, to debt as a financing tool issued to commit management to produce higher output, and to many other strategic investments.

The bottom line of this discussion is that in evaluating market structures and the behaviour of market leaders we should be especially careful to the entry conditions. Standard results on aggressive price and non-price strategies with exclusionary purposes emerging for markets with an incumbent and an entrant can change in radical ways when we take in consideration the possibility of entry of other firms. After all, antitrust policy in an uncertain world should

derive from a comparison of the expected losses from incorrectly challenging a practice that benefits consumers (a *Type I error*) versus the expected losses from incorrectly failing to challenge a practice that harms consumers (a *Type II error*). We believe that while the Chicago School has been too biased to reduce the first kind of losses (exactly because it largely ignored strategic interactions), the post-Chicago approach has been excessively biased in the opposite sense (exactly because it often neglected endogenous entry).

Competition in the high-tech markets is dynamic in the Schumpeterian sense that it takes place as competition for the market in a so-called winner-takes-all-race, and such an element requires an even deeper rethinking of competition policy than suggested in the analysis of the previous section, which was mostly focused on a static concept of competition in the market. Economic research has emphasized the positive relationship linking patents to investments in innovation and these investments to technological progress and growth. In high-tech sectors (think of hardware, software, pharmaceuticals, biotechnology) firms compete mainly by innovating. This is possible as long as there are well defined intellectual property rights (IPRs), and especially patents, protecting their innovations and investments, which is ultimately what leads to technological progress in our economies. Moreover, even if most economists are used to thinking about market leaders as firms with weaker incentives to invest in R&D, recent theoretical and empirical research has also found that market leaders can play a crucial role in the innovative activity.

The theory of market leaders (see for instance Etro, 2004) has clarified the mechanics of these results. In a sense, IPRs drive competition through innovation in these markets and induce technological progress led by incumbent monopolists under two conditions: their leadership in the contest to innovate and free entry of outsiders in this same contest. When an incumbent monopolist is the leader in the contest for innovating, the pressure of a competitive fringe of potential innovators leads this monopolist to invest more than any other firm: the competitive environment spurs investment by leaders and consequently induces a chance that their leadership persists. Moreover, when the leadership persists because of the endogenous investment in R&D by the leaders, the same value of becoming a leader is increased, which increases even further the incentives for any firm to invest, and so on. Paradoxically, the persistence of a leadership in high-tech sectors can be a sign of effective dynamic competition for the market, which leads to a faster rate of technological progress in the interest of consumers.

Notice that our results on the relation between entry in the competition for the market and investment by the incumbent monopolists can be seen as strengthening our initial claim that standard indexes of market concentration or market shares should not be related to the degree of competition in a market. In high-tech markets where competition is mostly for the market, it is natural that better products conquer large shares and, exactly when entry is free, incumbent patent holders have more incentives to invest and their leadership is more likely to persist. Hence there is no basis to relate in a significant way market shares and market power in dynamic sector.[4]

Of course, it is not our objective to take all these results literally. What we would like to emphasize is the importance of entry conditions in the market for innovations. Industrial policy, including antitrust policy, should primarily promote, and possibly subsidize, investment in R&D, while it should be less relevant whether the incumbent monopolist or new comers invest in R&D and innovate once entry is free. On the other side, the protection of IPRs should be established at a legislative level (possibly even coordinated at an international level) because its stability is essential to foster investments, while the discretionary activity of antitrust authorities should not affect the basic principle of IPR protection.

3. MARKET STRUCTURES AND MARKET LEADERS IN THE NEW ECONOMY

After examining theoretical and institutional aspects of the behaviour of market leaders and of the role of antitrust policy, we now approach a famous example of market leadership and technological leadership which is also associated with well known antitrust issues, that of the leader of the software market. The choice of Microsoft as a symbol of market leadership is somewhat natural: Microsoft is one of the most visible and relevant companies in the New Economy, one of the most innovative firms in one of the most dynamic industries and the antitrust cases in which this company has been involved in both the US and the EU attracted

[4] This mechanism is even more radical in markets with network effects, where the natural outcome is a sequence of dominant paradigms associated with market leaders whose behaviour is still constrained by innovative competitive pressure. Scotchmer (2004, p. 296), in her discussion of network effects, emphasizes this point neatly: "All this calls into question whether an incumbent's share of a network market is a good test of market power for antitrust purposes. With "tippy" markets, any snapshot of the market will find some firm with a dominant market share. But sequential monopoly is only a problem for competition policy if the price charged by each sequential monopolist is high [...] the price is constrained at first by the proprietor's need to attract users of the previous product, and later by a fear of scaring users into embracing a successor. The same fears will cause the incumbent to keep innovating."

primary attention of media, policymakers and observers. Many important economists were inspired by the Microsoft case in developing theoretical and empirical analysis on the structure of the software market, on the role of Microsoft in this market and on the role of antitrust policy in the New Economy.

In a recent important book, Evans, Hagiu and Schmalensee (2006) have emphasized the crucial role that software platforms are playing in shaping our economies, the functioning and the development of many sectors, and ultimately our way of living. These "invisible engines", as they call them, power not only the PC industry but also other industries as those associated with mobile phones and other handheld devices, video games, digital music, and (with strong externalities for the rest of the economy) on-line auctions, online searches and web-based advertising. Their convincing claim is that, as the steam engine was at the basis of the first industrial revolution (1760-1830) and electric power at the basis of the second industrial revolution (1850-1930), microprocessors and software platforms are at the basis of the third industrial revolution (since 1980), which started with the introduction of commercial PCs and had a second phase starting in 1995 with the Internet. What follows is largely based on the academic debate on the New Economy, however, our aim is not to provide a general analysis of the software market, but just to point out a few relations between our theoretical results on the behaviour of market leaders and the role of Microsoft in its market.

3.1. A Look at the Software Market

The software market was developed in the last few decades. In the 1960s, the computer industry was dominated by IBM, which manufactured mainframe computers that were used by large enterprise customers. These computers were expensive to purchase and expensive to maintain. As a result, very few consumers had access to computers. There was little or no interoperability among mainframes from different vendors. For the most part, an enterprise customer was required to choose an all IBM solution or an all Nixdorf solution. In the 1970s, Digital Equipment achieved considerable success with a line of less expensive minicomputers that were well-suited to engineering and scientific tasks. Again, however, there was little or no interoperability between these minicomputers and mainframes offered by IBM and others. The structure of the industry at that time was still largely vertical. By 1980, a number of companies had started offering less expensive microcomputers which were not interoperable

with one another. Early PCs by Altair, Tandy, Apple, Texas Instruments, Commodore and Atari ran their own operating systems, meaning that applications written for one brand of PC would not run on any other brand: the industry was fragmented. Apple, founded by Steve Jobs and Steve Wozniak, developed a very successful software platform, especially because of VisiCalc, an electronic spreadsheet which appeared in 1979 and soon became a killer application for Apple II.

In the early 80s IBM introduced an IBM personal computer. The first one was offered with a choice of three operating systems: CP/M-86 from Digital Research, UCSD-P System by Softech and PC-DOS developed by Microsoft, that kept the right to license its operating system to other PC makers, under the name MS-DOS. This drove its success in the software market. As Evans et al. (2006) noticed, for IBM, "having multiple operating systems run on a hardware platform is a poor strategy. The idea, of course, was to ensure that the hardware, not the operating system, became the standard that defined the platform and determined its evolution. Indeed, IBM followed an important economic principle for traditional industries: all firms would like everyone else in the supply chain to be competitive. IBM didn't seem to recognize that this was far from a traditional industry... Applications are generally written for software platforms, not the underlying hardware. The more fragmented the installed base of operating systems, the less attractive it is to write an application for any one of them." Not surprisingly, IBM's multiple-OS strategy did not work, the hardware sector became always more fragmented, with many PC manufacturers producing clones of the IBM PC and most of them running MS-DOS, the exact replica of the operating system running on IBM PCs. In the second half of the 80s IBM reacted by developing a new operating system, OS/2, while Microsoft independently developed Windows, whose lead at that point became unreachable. According to some observers, IBM based its strategy on its brand name and its research capacity, while Microsoft invested more in supporting the developers of software applications and in what is often called "evangelization": convincing software producers to develop applications for Windows. This was the winning strategy: the share of IBM in the market for the so-called IBM-compatible PCs decreased over time (in 2004 IBM arrived to the point of selling its PC division to Lenovo), while the market share of Microsoft in the software market increased.

Over time, the computer industry moved from the old vertical structure toward a horizontal structure with a market for chips (Intel as a leader, Motorola, ARM, TI, AMD,..), one for

hardware and peripheral equipment (IBM, Hewlett-Packard Dell, Packard Bell, Compaq, Acer,..), one for operating systems (Windows as a leader, OS/2, Unix, Linux, Solaris,..), one for application software (Office, Scientific Workplace, Macromedia Dreamweaver,..) and one for sales and distribution, with competition within horizontal levels and higher interoperability across levels. In general, such a decentralized structure can work well when technical interactions between complementary products become stable and well defined, and a vertical structure becomes too rigid to control them (the same happened in the mobile phone and personal organizer industries). Even Apple, that kept being a fully integrated structure producing both hardware and software for its PCs, had to become quite active in attracting applications from other software developers.

3.2. Network effects

A software platform is a software program that makes services available to other software programs through Application Programming Interfaces (APIs). Examples are the operating systems running on PCs as Windows, Mac OS or Linux, those employed by videogame consoles as the Sony one for PlayStation or Windows 2000 for the Xbox, the Symbian operating system for cellular phones, Palm OS for personal digital assistants (PDAs), RIM for the BlackBerry, iPod OS for the Apple iPod, and so on.

To understand the peculiarities of the software market in general it is convenient to focus briefly on the main functions of PC operating systems. The main one is to serve as a platform on which applications (such as spreadsheets or word processors) can be created by software developers. Operating systems supply different types of functionality, referred to as system services, that software developers can call upon in creating their applications. These system services are made available through APIs. When an application calls a particular API, the operating system supplies the system service associated with that API by causing the microprocessor to execute a specified set of instructions. Software developers need well-defined platforms that remain stable over time. They need to know whether the system services on which their applications rely will be present on any given PC. If they did not, then software developers would have to write the software code to provide equivalent functionality in their own applications, generating redundancy, inefficiency and a lack of interoperability. Moreover, modern OSs provide a user interface, the means by which a user interacts with his

computer. User interfaces for computers have evolved dramatically over the last decades, from punch card readers, to teletype terminals, to character-based user interfaces, to graphical user interfaces, first introduced by Apple with Macintosh. Finally, operating systems enable users to find and use information contained in various storage devices: local ones, such as a floppy diskette, a CD-ROM drive or the hard drive built into a PC, or remote ones, such as local area networks that connect computers in a particular office, wide area networks that connect computers in geographically separated offices, and the Internet.

Over time, the OS of Microsoft became the most popular because Microsoft continually added new functionality to the OS and licensed it to a wide range of computer manufacturers with extremely aggressive pricing strategies. Microsoft recognised early on that an OS that served as a common platform for developing applications and could run on a wide range of PCs would provide substantial benefits to consumers. Among other advantages, development costs would fall and a broader array of products would become available because products could be developed for the common platform rather than for a large number of different platforms. By providing a single OS that ran on multiple brands of PCs, Microsoft enabled software developers to create applications, confident that users could run those applications on PCs from many different computer manufacturers. In addition, applications developed for a single platform are more easily interoperable because they rely on the same functionality supplied by the underlying OS.

The winning strategy of Microsoft was the creation of these network effects between hardware producers, software developers and consumers. Katz and Shapiro (1985) have formulated the first theory of competition with network externalities, showing how these typically lead to winner takes all results.

3.3. Multi-sided platforms

Software platforms, as we have seen, deal with multiple sides. Microsoft deals with at least three: consumers, software developers and PC manufacturers. Apple produces hardware internally, hence it deals with the remaining two sides: consumers and software developers. Sometimes relationships are even more complex, as in the platform ecosystem for smart mobile phones where, beyond OSs, software developers and handset makers, there are

network operators (Vodafone, NTT DoCoMo, T-Mobile, Tim,..) to play a coordinating role and even competition between layers is strong.

In the presence of multiple sides with network effects between them, the choice of which ones should be charged more to use the platform is not simple. Rochet and Tirole (2003) and others have noticed that software platforms, as other similar multi-sided platforms, give rise to market structures that are quite different from traditional ones. For simplicity, here we will refer to two-sided platforms, which connect two sides in such a way that for each side the valuation of the interactions with the other side depends on the number of agents on the others side. These network externalities, and in particular the non neutral impact of the pricing structure on both sides (and hence on these externalities) distinguishes a two-sided market from a traditional one-sided market with different consumers (and possibly price-discrimination between them).

An analogous situation to software platforms emerges in many completely different contexts. A classic example is given by newspapers. They are sold to readers, but they also sell advertising space to advertisers: the reader is not only a "customer" of the newspaper, the reader is also a supplier of "eyeballs" that the newspaper sells to advertisers. Here, network effects emerge because advertisers (the sellers for the platform) value their advertising more in a newspaper when the number of its readers (the buyers of the platform) is higher (the effect in the other direction may exist but is typically less important). This has crucial consequences on the pricing structure since a low price for the readers increases the number of sold copies and hence the value of advertising. Such a phenomenon is even stronger when the newspaper is competing with other newspapers, and a low price reduces the readers of competing newspapers and the value of advertising on these competing newspapers.

Other two-sided platforms include other media networks as television channels, real estate agencies, traditional auction houses, shopping malls, night clubs and dating clubs, payment card systems, telephone networks and many industries of the New Economy as those related with video game consoles, smart phones, digital music, PDAs, i-Mode, search engine-based portals (like Google), on line messaging (like Yahoo!), on line chatting (like Skype), on line videos (YouTube), on line academic articles (JSTORE or SSRN), on line shopping (Amazon) and on line auctions (eBay). In many of these markets, multi-homing on at least one of the two sides is common: people often buy more than one journal or watch more TV channels (as companies advertise on multiple medias), hold multiple credit cards (as merchants accept

multiple cards) and software developers prepare applications for multiple OSs (while individuals typically use only one).

In each one of these examples, network externalities are crucial to the success of a software platform, and the pricing structure toward buyers and sellers is crucial to the creation of these network effects. In particular, a platform typically ends up charging one of the two sides less than the other, taking into account demand elasticities and which side values the other side more: the aim is to get on board as many agents as possible from one side, so as to increase the value of the platform for the other side and earn more revenue from it. For instance, when the price is the strategic variable, it is optimal to charge the side whose demand is more elastic relatively more because this allows one to maximize the total volume of interactions. Prices will be constrained downward when there are competing platforms (especially in case of multi-homing), but the general principles on a balanced price structure between the two sides remain unchanged. In extreme cases, one side may even receive its goods or its services for free or even be subsidized so as to maximize earnings from the other side.

The above theoretical implications are surprisingly confirmed by what happens in the above mentioned two-sided markets, whose companies typically settle on pricing structures that are heavily skewed toward one side of the market, or in other words adopt what is sometimes called a "divide and conquer" strategy. Newspapers, television networks and even websites typically earn more from advertisers than from consumers, real estate agencies earn more from sellers (or from landlords) than from buyers (or renters), auction houses from sellers rather than from the buyers, shopping malls from stores rather than from the shoppers, night clubs from men rather than from women, payment card companies from merchants rather than from cardholders, phone operators (often) from call makers rather than from receivers, video game platforms from royalties on game developers rather than from buyers of consoles (that are often sold below cost), while most of the other software platforms, including PC operating systems, earn more from end users rather than from software developers.

Notice that, in spite of the network effects, most of these two-sided markets are also characterized by a certain degree of fragmentation between platform providers (real estate agencies, dating clubs, traditional auction houses), often associated with a certain degree of differentiation (newspapers, TV channels and other medias, shopping malls). Only when technological innovation is particularly important and fixed costs of investment in R&D are

high (while marginal costs of production are particularly low), the number of competing platforms is endogenously reduced, as in the above mentioned markets of the New Economy (but tipping on a single leader rarely happens, especially when product differentiation and multi-homing have a role, as for video games). Nevertheless, even in these cases, competition for the market can be quite effective and induce periods of persistent leadership with occasional replacement of the leader: pathbreaking innovations (or "killer applications") is what competitive firms really look for.

For instance, in the console video game industry, sequential innovations brought to leadership a number of companies as Atari (that reached 80% share of the market in 1980), Nintendo (90% of the market in 1987), Sega (leader in the early 90s), Nintendo again (in the mid 90s) and Sony with the PlayStation in different improved versions (during the last decade): recently Microsoft Xbox started gaining market shares, and Nintendo is still active, but the leadership of Sony (58% market share in 2004) does not appear under threat yet, especially after the recent successful launch of PlayStation 3. Similarly, after a number of unsuccessful attempts by many companies, Palm's PDA gained success and leadership in the market for OSs for organizers thanks to a simple handwriting recognition system (65% market share in 2000) until Microsoft competing platform and other handheld devices, including Blackberry and (in perspective) Apple's iPhone, gained success.

3.4. Microsoft

Microsoft was founded in 1975 by Bill Gates and Paul Allen to develop BASIC interpreters for the first PC, Altair 8800, and then other programming languages. Only later, did it start producing major software programs. In 1981, Microsoft released its first operating system, MS-DOS, which had a character-based user interface that required users to type specific instructions to perform tasks. In 1985, Microsoft introduced a new product called Windows that included a graphical user interface, enabling users to perform tasks by clicking on icons on the screen using a pointing device called a mouse (basically the only piece of hardware produced by Microsoft for PCs). Windows 3.0, shipped in 1990, was the first commercially successful version of Windows. In 1995, Microsoft released Windows 95, which integrated the functionality of Windows 3.1 and MS-DOS in a single operating system. In 2000, Microsoft shipped Windows 2000 Professional, a new generation of PC operating system

built on a more stable and reliable software code base than earlier versions of Windows. Windows XP represented a further evolution with a range of added functionality for both business and home users. Finally Windows Vista has been released worldwide in 2007: it was the fruit of five years of work by 8000 designers, programmers and testers and of an estimated investment of $ 10 billion to rewrite from scratch a new code, largely under the pressure of innovative forces deriving from the open source community and also with the support of many large corporations willing to strengthen valid alternatives to Windows.

Even if complete and homogenous data are unavailable, consistent evidence suggests that the market share of Windows on sales of OSs for PCs rapidly increased towards 80% in the first half of the 90s to gradually arrive at 92% in 1996, 94% in 1997, 95% in 1999, 96% 2001, and remained basically at this level since then (while the average consumer price of Windows, calculated as average revenue per licence to PC manufacturers based on Microsoft sales, remained around $ 44-45). Nevertheless, one should keep in mind that a minor group of PC users (but strongly increasing in number, especially between expert users)[5] downloads open source operating systems from the Internet, and that on the top of this market there are Apple computers running Mac OS. Anyway, it is clear that Microsoft has reached a robust leadership in the PC operating systems market for Intel-compatible computers.

Beyond OSs, Microsoft is leader in other markets for software applications. Some essential applications have been freely bundled with the operating system: for instance a basic word processing software (WordPad), a browser to access Internet and media player functionalities have been gradually added for free to subsequent versions of Windows when they became standard components of a modern OS. Other more sophisticated applications are supplied separately. Most notably this is the case of the Office Suite consisting of the word processor Word (first edition released in 1983), the spreadsheet Excel (1985), the presentation software PowerPoint (1987) and more. The main two applications, Word and Excel, have been successfully competing against alternative products like WordPerfect, WordStar, AmiPro and others on one side and Lotus, Quattro and others on the other side. Liebowitz and Margolis (1999) have shown convincing evidence for which a better quality/price ratio together with network effects were at the basis of this evolution (it is important to note that Microsoft achieved leadership in the Macintosh market, hence without exploiting the presence of its own OS, considerably earlier than in the PC market).

[5] Estimates for the percentage of server computers running Linux worldwide are in the range of 20-25%. Desktop computers running Linux are about 3%.

In the market for word processing applications, Microsoft's market share was hardly above 10% at the end of the 80s, but gradually increased to 28% in 1990, 40% in 1991, 45% in 1992, 50% in 1993, 65% in 1994, 79% in 1995, 90% in 1996, 94% in 1997 and arrived to 95% in 1998, remaining around this level afterward. Meanwhile the average consumer price of Word (calculated as average revenue per license) decreased from $ 235 in 1988 to $ 39 in 2001. In the market for spreadsheet applications, Microsoft followed a similar progress, with a market share of 18% in 1990, 34% in 1991, 43% in 1992, 46% in 1993, 68% in 1994, 77% in 1995, 84% in 1996, 92% in 1997 and 94% in 1998, with minor progress in the following years, while the average consumer price of Excel was decreasing from $ 249 in 1988 to $ 42 in 2001.

Finally, Microsoft is also active in other strategic markets as a follower, in particular with personal finance software, a video game console, Xbox (the leader being Sony PlayStation, with a 65% market share in 2004), an operating systems for smart phones, Windows CE (the leader being Symbian, with a 60% market share in 2004), a search engine MSN (the leader being Google, with more than 80% of searches on the Internet) and more. In 2006, Microsoft, led by Steve Ballmer who replaced Bill Gates as CEO in 2000, had revenues of $ 44.2 billion, 60% of which derives from Windows and Office, and net income of $ 12.4 billion, 80-90% of which derives from Windows and office.

4. ANTITRUST ISSUES AND THE MICROSOFT CASE

Microsoft's leading position induced large opposition in the industry and the emergence of multiple antitrust cases with importance at a global level.

In the main Microsoft vs. US case, started in 1998, the software company was accused of protecting its monopoly in the OS market from the joint threat of the Internet browser Netscape Navigator and the Java programming language, which could have developed a potential substitute for OSs allowing software applications to run on hardware independently from the desktop OS. Basically, the hypothetical threat for Microsoft was the development of an alternative to the software platform based on the OS, a sort of middleware platform or a web-based platform leading to the “commoditization” of the OS (as ten years before the software platform led to the commoditization of hardware), and hence to the loss of leadership of Microsoft. Microsoft reacted by improving its Internet Explorer (IE) browser,

engaging in contractual agreements with computer manufacturers and Internet service providers (notably AOL, whose "You've got mail" sound track was attracting more than 20 millions Americans at the time) to promote preferential treatment for IE, and finally tying Windows with IE. For perspectives by economists who were active in the case see Fisher and Rubinfeld (2001) and Bresnahan (2001) on the US Government side and the essays in Evans (2002) on the Microsoft side.

As Klein (2001) has pointed out in an academic survey on the Journal of Economic Perspectives (Symposium on the Microsoft case), "Microsoft spent hundreds of millions of dollars developing an improved version of its browser software and then marketed it aggressively, most importantly by integrating it into Windows, pricing it at zero and paying online service providers and personal computer manufacturers for distribution. All of this was aimed at increasing use of Microsoft's Internet Explorer browser technology, both by end users and software developers, to blunt Netscape's threat to the dominance by Windows of the market for personal computer operating systems." Microsoft's investments in browser technology, which largely improved IE until it became a superior product compared to Netscape Navigator (see the empirical analysis in Liebowitz and Margolis, 1999), and Microsoft's pricing of IE at zero (as always since then) appear to us as examples of aggressive strategic investment and aggressive pricing by a market leader facing competition and not as anti-competitive strategies.[6] According to Klein (2001), "a crucial condition for anticompetitive behavior in such cases is that the competitive process is not open. In particular, we should be concerned only if a dominant firm abuses its market power in a way that places rivals at a significant competitive disadvantage without any reasonable business justification. Only under these circumstances can more efficient rivals be driven out of the market and consumers not receive the full benefits of competition for dominance. The only Microsoft conduct...that may fit this criteria for anticompetitive behavior are the actions Microsoft took in obtaining browser distribution through personal computer manufacturers."

After a failed attempt by Judge Richad Posner (the father of the Chicago School to antitrust) to mediate in settlement negotiations, Judge Thomas Penfield Jackson decided to

[6] In our view, the US case was characterized by a too limited focus on rigorous economic arguments in support of the different thesis. It is ironic that Microsoft's internal documents and emails including aggressive expressions toward competitors were used to support the idea that Microsoft undertook its browser development for entry deterrence purposes. It is hard to see how the aggressive language of business people can prove more than competitive intent (on the use of internal documents to prove antitrust violations, see Manne and Williamson, 2005).

impose heavy behavioral and structural remedies on Microsoft, including the break up in an operating system and an application company (the so-called "Baby Bills", as Baby Bells were the companies derived from the 1984 brake up of AT&T). At the time, this draconian remedy was criticized by many economists with different perspectives on the case, for excessively penalizing the company without a clear relation between the punishment and the alleged crime, and for inducing perverse consequences for consumers. For instance, on the pages of *The New York Times*, Krugman (2000, Reckonings: Microsoft: What's Next?, April 26) pointed out the risk of creating two monopolists engaging in double marginalization : "The now `naked' operating-system company would abandon its traditional pricing restraints and use its still formidable monopoly power to charge much more. And at the same time applications software that now comes free would also start to carry heftly price tags".[7]

After the appeal phase, the November 2002 ruling of the District of Court decided on behavioral remedies aimed at preventing Microsoft from adopting exclusionary strategies against firms challenging its market power in the market for operating systems. Moreover, the Court adopted forward looking remedies that required limited disclosure of APIs, communication protocols, and related technical information in order to facilitate interoperability, and created a system of monitoring of Microsoft's compliance which has been working quite well in the last years. Since other derivative private actions have also been dismissed or settled, it seems that this long-standing conflict has arrived to its end in the US.

The Microsoft vs. EU case was subsequently developed on somewhat similar issues. In particular Microsoft has been accused of abuse of dominance in the market for OSs through technological leveraging, refusing to supply competitors with the interface information needed to achieve interoperability with Microsoft software, and bundling Windows with Media Player, a software for downloading audio/video content. At the time of writing, the case is still unresolved: Microsoft's Appeal of the Commission's March 2004 antitrust decision was heard by the European Court of First Instance in April 2006 and a decision is expected during 2007. In the 2004 landmark decision, the Commission imposed the largest

[7] Judge Jackson was later disqualified for violating a number of ethical precepts and being manifestly biased against Microsoft. Nevertheless, it should be added that the government proposal of splitting Microsoft into two companies, which was adopted by the Judge without substantive changes, had been supported by declarations of important economists, including Paul Romer and Carl Shapiro. For instance, Shapiro declared that, while "network monopolies can be very strong, they are most vulnerable to attack by firms with a strong position in the provision of a widly-used complementary product", hence "the proposed reorganization of Microsoft into separate applications and operating systems businesses will lower entry barriers, encourage competition and promote innovation" (Declaration of Carl Shapiro, U.S. v. Microsoft Corp., Civil Action N0. 98-1232 (TPJ), p. 7 and p 29).

fine in the history of antitrust (497 million Euros), required Microsoft to issue a version of its Windows operating system without Media Player, and mandated the licensing of intellectual property to enable interoperability between Windows PCs and work group servers and competitor products.

While a comprehensive analysis on the PC operating system market and of the role of Microsoft is beyond the scope of this article, we can try to provide a basic interpretation of a few features of this market through the simple models developed in the theory of market leaders discussed in the previous sections. The technological conditions in the software market are quite known. Production of an operating system takes a very high up-front investment and a constant and low (close to zero) marginal cost. Network effects in the development of a market for an OS are crucial, and the pricing structure is fundamental to get on board both end users and application developers. Beyond this, a firm producing OSs faces competitors: the entry conditions in the market for OSs are quite debated, but there are good reasons to believe that even though entry into the software market may entail large costs, it is substantially endogenous. First of all, there are already many OSs available (for instance Solaris by Sun Microsystems, many versions of Unix and Linux, those by Red Hat and Novell), many firms producing OSs for related industries (smart phones, PDAs, videogames), and even more potential entrants (think of the giants in adjacent sectors of the New Economy, hardware and telecommunications in particular). Second, it is hard to think of a market which is more "global" than the software market: demand comes from all over the world, transport costs are virtually zero, and the knowledge required to build software is accessible worldwide.

Nevertheless, it has been claimed that in the market for OSs, the high number of applications developed by many different firms for Windows represents a substantial barrier to entry. Unfortunately, such a claim usually leads to misleading conclusions. It is true that competitors need to offer (and some do offer already) a number of standard and technologically mature applications upon entry to match the high quality of the Windows package and create network effects, but the cost of offering these applications is unlikely to be prohibitive compared to the global size of this market.[8] There are at least two reasons for this. First, notice that the alleged "applications barrier to entry" is often erroneously associated

[8] There are many examples of markets with network effects where subsequent entrants managed to create network effects and challenge incumbents. In the New Economy a clear example emerges in many markets, for instance in the case of payment cards (where network effects are quite important), which absorbed sequential entry by Diners Club (1950), American Express (1958), Visa (1966), MasterCard (1966) and Discover (1985), to name the most famous ones.

with thousands of applications written for Windows, while it is actually limited to a handful of applications such as word processing, spreadsheet, graphics, internet access and media player software, which really satisfy the needs of most active computer users (McKenzie, 2001). Second, the competitors of Microsoft should not (and the existing ones do not) even finance the development of all the needed applications: they should just fund and encourage other firms to write applications for their operating system, or have old applications originally written for other operating systems "ported to" theirs, which is what already happens since multi-homing for OSs is common practice on the software developer side of the PC operating system platforms.[9] Finally, it is important to emphasize that if we look at competition in the software market in a dynamic sense, that is competition for the market (as opposed to competition in the market) or through innovations, there is no doubt that the opportunity to invest in innovations for future, better software is widely open not only to large companies in the New Economy, but even to smaller ones.

Summarizing, the software market is characterized by network effects, high costs of production, constant marginal costs close to zero and substantially open access by competitors able to create new software. According to the theory of market leaders these are the ideal conditions under which we should expect a leader to produce for the whole market with very aggressive (low) prices. Hence, it should not be surprising that, at least in the market for operating systems, a single firm, Microsoft, has such a large market share. We can see the same fact from a different perspective: since entry into the software market is endogenous, the leader has to keep prices low enough to expand its market share to almost the whole market.

Many economists agree on the fact that Microsoft sells Windows at an extremely low price. For instance, Fudenberg and Tirole (2000) notice that both sides in the US Microsoft case agreed that "Microsoft's pricing of Windows does not correspond to short run profit maximization by a monopolist. Schmalensee's direct testimony argues that Microsoft's low prices are due at least in part to its concern that higher prices would encourage other firms to develop competing operating systems" even if, they add, "neither side has proposed a formal model where such `limit pricing' would make sense." To formalize this argument, assume for simplicity that the marginal cost of producing Windows is zero, and that the price of hardware

[9] In 2000, it has been estimated that 68 % of software companies developed applications for Windows, 19 % for Apple (which requires adapting to both unique software and hardware), 48 % for various versions of Unix and Linux and 36 % for other proprietary OSs (see Lerner, 2001). Notice that the respective percentages in 1992 were 71%, 12%, 33%and 31%, hence competing OSs experienced an increase in software developers compared to Microsoft during the 90s.

is constant and independent from the price of Windows. Standard economic theory implies that the monopolistic price for an operating system should be the price of the hardware divided by ε-1, where ε is the elasticity of demand for PCs (including both hardware and software): it means that a 1% increase in the price of PCs reduces demand by ε %. Now, this relationship tells us that, if the basic price of the hardware is 1000 Euros, which is about the current average price for a PC, the monopolistic price for Windows would be other 1000 Euros if ε = 2, it would be 500 Euros if ε = 3, and so on. It would take really unreasonable values of demand elasticity to even get close to the real price of Windows, which is around 50 Euros. Moreover, let us remember what we found in our previous discussion on the software platforms: a two-sided platform as Windows earns its revenue entirely from end-users, and not from software developers, that are typically subsidized by Microsoft to develop new and better applications to strengthen network effects. Hence, the low price of Windows appears even more distant from what should be the hypothetical monopolistic price.

Hall and Hall (2000) developed similar calculations to the one above assuming Cournot competition in the hardware market and suggested that Microsoft has to adopt a low price for Windows as a rational strategy in front of endogenous entry in the OS market. Their conclusion is consistent with the results of the theory of market leaders: "not only is the price of Windows brought down to a small fraction of its monopoly price, but the social waste of duplicative investment in operating systems is avoided as well."

It has been claimed that low Windows pricing may be explained with the higher pricing of the complementary applications, as the Microsoft Office suite. However, the combined price of Windows and the average application package sold with it is still below the monopolistic price. Moreover, these applications are not sold at lower prices for other operating systems. Finally, as Economides (2001) pointed out, "Windows has the ability to collect surplus from the whole assortment of applications that run on top of it. Keeping Windows' price artificially low would subsidize not only MS-Office, but also the whole array of tens of thousands of Windows applications that are not produced by Microsoft. Therefore, even if Microsoft had a monopoly power in the Office market, keeping the price of Windows low is definitely not the optimal way to collect surplus."

What does all this tell us? Simply that Microsoft is not an unconstrained price-setter, while its prices are limited well below the monopolistic price to compete aggressively with the other firms active in the operating system market and with the potential entrants in it. Economides

(2001) concludes in a similar fashion: "Microsoft priced low because of the threat of competition. This means that Microsoft believed that it could not price higher if it were to maintain its market position." Indeed, we can say more than just that Microsoft is not a monopoly. What the post-Chicago approach suggested about leaders in markets with price competition was that they should be accommodating and exploit their market power, setting higher prices than competitors, or otherwise engage in predatory pricing and, after having conquered the whole market, increase prices. But in the last 10-15 years of global leadership, Microsoft has done neither of these things. Microsoft has been constantly aggressive, as any firm under the threat of competitive pressure would be. The theory of market leaders has shown that a market leader in these conditions would price above marginal cost in such a way to compensate for the fixed costs of investment and obtain a profit margin (over the average costs of production) thanks to the economies of scale derived from the large (worldwide in the case of Microsoft) scale of production. Its (quality adjusted) price should be below that of its immediate competitors or just low enough to avoid that they can exploit profitable opportunities increasing their prices.[10]

4.1. Bundling and the Microsoft Case

One of the issues where the new theory of market leaders applies and provides new insights for antitrust policy is bundling, that is, the combination of two separate products in a single one sold alone. Virtually any product is a bundle, since it combines multiple basic products which could be or are sold separately: a car bundles many separate components, shoes bundle shoes without laces and shoelaces, a computer bundles hardware, an operating system and basic software applications of general interest. In some cases, bundling is just a contractual restriction used to force customers to purchase an ancillary product in an aftermarket for goods or services, while in other cases bundling improves a finished product by integrating new components or features into it: of course, only the first situation should be subject to antitrust investigation.

[10] In 2000, it has been estimated that 68 % of software companies developed applications for Windows, 19 % for Apple (which requires adapting to both unique software and hardware), 48 % for various versions of Unix and Linux and 36 % for other proprietary OSs (see Lerner, 2001). Notice that the respective percentages in 1992 were 71%, 12%, 33%and 31%, hence competing OSs experienced an increase in software developers compared to Microsoft during the 90s.

As we noticed earlier, there are contrasting views on bundling. The Chicago school has advanced efficiency rationales in its favour with positive, or at worst ambiguous, consequences on welfare, including production or distribution cost savings, reduction in transaction costs for customers, protection of intellectual property, product improvements, quality assurance and legitimate price responses. Moreover, according to the so-called "single monopoly profit theorem", as long as the secondary market is competitive, a monopolist in a separate market cannot increase its profits in the former by tying the two products. Actually, in the presence of complementarities, it can only gain from having competition and high sales in the secondary market to enhance demand in its monopolistic market. A similar idea has been advanced at a theoretical level by Davis and Murphy (2000) and by Economides (2001) to explain the tying strategies of Microsoft. With particular reference to the US case, Economides (2001) notes that Microsoft could not have been interested in the browser market when this was perfectly competitive, but only when this market became dominated by Netscape for two main reasons. “First, Netscape had a dominant position in the browser market, thereby taking away from Microsoft's operating system profits to the extent that Windows was used together with the Navigator. Second, as the markets for Internet applications and electronic commerce exploded, the potential loss to Microsoft from not having a top browser increased significantly... Clearly, Microsoft had a pro-competitive incentive to freely distribute IE since that would stimulate demand for the Windows platform.” The very same point could be made for the free distribution of Media Player with Windows, the subject of the tying part of the EU case.

The post-Chicago approach has shown that, when the bundling firm has some market power, commitment to bundling can only be used for exclusionary purposes since it enhances competition in the secondary market and increases the profits of the leader only if it excludes rivals from this secondary market (Whinston, 1990). Nevertheless, even the same proponent of this theory has expressed doubts on its applicability to Microsoft: evaluating the tying of Windows and IE, Whinston (2001) notes that “Microsoft seems to have introduced relatively little incompatibility with other browsers. Since marginal cost is essentially zero, bundling could exclude Netscape only if consumers, or computer manufacturers for them, faced other constraints on adding Navigator to their system”, which did not appear to be the case.

As we have formally shown, the theory of market leaders emphasizes that when entry in the secondary market is endogenous, an incumbent may only gain in this market by adopting an

aggressive pricing strategy and in our framework, bundling the primary good and the secondary good is exactly a way to commit to aggressive pricing. Hence, bundling is the standard competitive strategy of the incumbent as long as the reduction in the profits in the primary market is compensated by the gains in the secondary market. Of course, if there are some complementarities between the products, or there are unexploited network effects, the expansion of demand following the bundling strategy with aggressive pricing can make bundling more likely to be optimal. But what matters for our purposes is that bundling is not an extreme strategy adopted by an incumbent firm to deter entry, but a standard aggressive strategy that, by reducing the final prices, may indeed reduce entry by followers but would not exclude entry overall. As a matter of fact under some level of product differentiation the impact on the competitors is quite limited and only marginal firms of the secondary market would be driven out of it. Hence, in a world of price competition, it appears hard to conclude that bundling could be used as a predatory strategy when it does not lead to the exit of all the competitors, but just to a permanent reduction of the price level.

To sum up, when approaching a bundling case we suggest verifying the entry conditions of the secondary market. If there is a dominant firm in this market as well, the main problem is not the bundling strategy, but the lack of competition in the secondary market, and it should be addressed within that same market: punishing the bundling strategy would just guarantee the monopolistic (or duopolistic) rents of the dominant firm in the secondary market. However, things are different when the secondary market is not monopolized but open to endogenous entry (even if it is not perfectly competitive, in the sense that firms do not price at marginal cost). In such a case, and especially in the presence of product differentiation, bundling is a pro-competitive strategy and punishing it would hurt consumers.

In the case of Microsoft, we have the impression that in both bundling cases, that of Windows with Internet Explorer and that of Windows with Media Player, the tied market was characterized and (most of all) still is characterized by endogenous entry: just think of new successful browsers as Mozilla Firefox, Netscape, Safari, Opera, Konqueror and media player softwares as RealPlayer, Apple's QuickTime, Adobe's Flash, MusicMatch and others. Consequently the bundling strategy of Microsoft could be simply seen as an aggressive and competitive strategy of a market leader active in a secondary market where entry is indeed free. Moreover, in these markets the standard strategy is to provide free software to enhance network effects and earn from these indirect effects or from services associated with the use

of their software (a typical strategy in multisided markets, as we have seen). For instance, in the case of digital media platforms, Microsoft looks for indirect effects on licenses of its OS, Real earns from content subscriptions, Apple from selling digital audio and video devices (the iPod and, in perspective, the iPhone) and Adobe from Flash server sales. Even if these companies adopt very different business models, competition is quite intense especially because multi-homing is common practice: end users typically use multiple media players (that are characterized by a certain degree of horizontal differentiation), and also PC manufacturers typically install multiple competing mediaplayers at their will (while this is not the case for digital music devices and mobile phones). Finally, multi-homing is a clear symptom that media players are horizontally differentiated (some are better for music content, others for videos, others for storing files, and so on): from our previous discussion on bundling for secondary markets with endogenous entry and product differentiation, it follows that these are precisely the conditions where bundling assumes a competitive nature rather than a predatory one.

Beyond this, it should be added, that in dynamic markets as the software market, the same concept of a good is changing over time, since both demand and supply change. If demand by PC users for media player functionalities was limited just a few years ago, now it appears that these functionalities are an essential component of an OS. Because of this, an increasing number of software applications and on line services are associated with media player functionalities, so that demand is even strengthened by network effects. If supply of bundled media players functionalities within OSs was inefficient a few years ago and mostly left to specific adds on, improvements in hardware processing power, in the cost of hard disk storage and random access memory, and in the streaming technology made it simple and efficient to bundle media player functionalities within current OSs. As a consequence of this bundling has a natural technological rationale and should emerge endogenously when the size of demand is large enough and the cost of supply is low enough. In other words, while a few years ago an OS and a media player could be regarded as separate goods whose union could be associated with a bundling strategy, nowadays a OS must incorporate media player functionalities (as it must incorporate a browser) so that we cannot even talk of a traditional form of bundling. In this perspective, the attempts of antitrust authorities to stop or delay the evolution of OS through additional features, as browsers and media players, appear quite dangerous: while it is difficult to verify in which moment it would be optimal to bundle secondary products in an

evolving primary product, it is not clear why antitrust authorities should have a better guess than market driven firms.

Notice that since the 2004 Commission's decision, Microsoft had to prepare and commercialize a version of Windows without Media Player in Europe. Soon after, it was noticed that "all we need to know is that if the remedy does have any impact, that's a sure sign that Microsoft abused its position and hence we should be happy to have the remedy in place. Just as King Solomon's proposal to divide the baby only caused pain to the true mother, the Commission's remedy will only cause pain to a monopolist who abused its position." (Ayres and Nabeluff, 2005). Demand for the version of Windows without Media Player has been virtually zero in Europe, a likely sign that Microsoft bundling strategy was at least not hurting consumers.

4.2. Innovation and the Microsoft Case

In the previous sections we discussed the role of market leaders in innovative markets and the importance of the protection of IPRs in stimulating investment in R&D and technological progress. Both aspects are quite relevant to understand the dynamics of the software market and the Microsoft case. The software market is a main example of an industry where competition is mainly for the market, and in such a market, as we have seen, large market shares by single firms are a typical outcome. The counterpart of this, of course, is that these markets can exhibit catastrophic entry where innovators can replace current leaders quite quickly. As we noticed, in such an environment, it is exactly when competition is open that leaders have incentives to invest deeply to retain their leadership. On the contrary, when competition is limited, technological leaders can have a quiet life and accept the risk that someone will come up with a better product, but when competition is open this same risk is too high and incumbents prefer to accept the challenge and try to innovate first, obtaining a more persistent leadership.

As noticed by the theory of market leaders (in particular Etro, 2004), innovation by leaders creates a virtuous circle that also has important implications for the way we can evaluate such a market. The endogenous persistence of the technological leadership has a value that gives incentives to all firms to invest even more, which in turn strengthens the same incentives of the leader to invest to retain its leadership, and so on. In other words, persistence of leadership

is a source of strong competition for the market (through investments in R&D to replace the current leader), and, given that leaders have higher incentives to invest as long as the race to innovate is open, we can also conclude that strong competition for the market is a source of persistence of leadership. This circular argument may appear paradoxical, but is the fruit of a radical distinction between static and dynamic competition: once again, there is not any consistent correlation between market shares and market power in dynamic markets.

The endogenous multiplicative effect of the value of leadership that we have just summarized implies that in dynamic markets the rents of a leader may be spectacularly larger than those of its competitors, and the market value of the leadership may be extremely large even if the market is perfectly competitive in a dynamic sense. In our view, this is something not too far from what we can see in the software market and in the leadership of Microsoft, but also in many other high-tech sectors.

Of course, the source of the value of innovation, the starting point of the chain of value that we just described, must be a fundamental rent associated with innovations and protected through IPRs. Hence, all forms of IPRs, including patents, copyrights and trade secrets, are the ultimate source of leadership, innovation and technological progress. As we already noticed the role of patent legislation is exactly to trade off the benefits of patents in terms of incentives to innovate with the costs related to temporary monopolistic pricing. In our opinion, there is no reason why antitrust authorities should interfere with this legislation every time patent protection appears inconsistent with other goals, as the EU Commission has been trying to do with Microsoft. And even if these goals were legitimate and relevant, introducing a discretionary evaluation of IPRs would create uncertainty and jeopardize the investment, which, after all, goes against the ultimate objective of the same antitrust authorities.

In the sectors of the New Economy, IPRs and trade secrets often cover fundamental inventions and protecting those inventions amounts to promoting innovations that are the main engine of growth nowadays. In some fields, however, there maybe, at least apparently, a trade-off between trade secret protection and “interoperability” between products, which is, broadly speaking, the ability to exchange and use information and data, especially in networks. For instance, take in consideration the leading on line search engine in the world, Google. We may look at Google's patented innovations, starting with the 2001 patent on the invention of the PageRank by Larry Page (founder of Google with Sergey Brin), but after that, we would need to know its trade secrets to fully discover the mechanism of its precious

algorithms. This would help many software companies and websites to interoperate with Google even better than they already do, as it would allow other search engines to improve their performances compared to that of the leading search engine. But after that, surely, few companies would invest huge resources and take substantial risks to create a leading search engine or other brilliant ideas like Google when they can just free ride on others' ideas and/or they can't be sure of their return. The same argument would apply for the trade secrets of Microsoft or Apple on the source codes of their OSs and to many other trade secrets of innovative leading companies. Any forced disclosure of similar trade secrets represents an expropriation of legitimate investments and establishes inappropriate legal standards with perverse effects on the incentives to innovate.

Fortunately, giving up the precious role of IPRs, in promoting innovations is not the only way to solve interoperability challenges. The market can do it much better: valuable ideas can be selectively commercialized on a voluntary basis through licenses. Coase (1960) has clarified that whenever there is social value to generate, the market will properly allocate all property rights, including intellectual ones, insuring the accessibility of the information that fuels interoperability and acknowledging legitimate ownership rights of the innovators, and hence enhancing R&D investments. Suppose firm A invests, innovates and obtains a patent, and firm B has a new idea to improve firm A's innovation, but this idea cannot be used without infringing the patent. Of course forced interoperability would lead firm B to implement its idea. However, in such a case firm A will not invest to start with and no idea will be actually implemented. Consider now agreements between the two firms. First, firm A could license its patent to firm B for a price between the expected profits that A and B can respectively obtain from marketing alone their respective ideas: if there is such a price, which depends on the respective bargaining power, the best idea is implemented and firm A will have all the interest to invest ex ante. Second, firm B could sell its idea to firm A at a price at most equal to the difference in expected profits that firm A can obtain respectively with firm B's idea and with its own patented innovation, with the price again depending on the bargaining power: again the incentives for firm A to invest ex ante would be preserved. This suggests that it may often be the same firm buying others' innovations (especially if this firm has developed a comparative advantage in marketing products) and it may often be other firms taking the initiative to invest in new fields with the aim of reselling their innovations.

This is indeed the way technological progress evolves in many industries under protection of IPRs.

Finally, in presence of network effects, dynamic market forces can do even more: as long as IPRs are well protected and firms can invest with the safe confidence that successful innovations will be rewarded, market forces can select the best standard when multiple standards are available and interoperability is only partial. Liebowitz and Margolis (1999) have shown that this is the case in many episodes. For instance, in the adoption of the QWERTY keyboard for PCs (so-called from the first five letters on the top left): for years it has been claimed that the allocation of letters of this keyboard was an inefficient standard, while these researchers found that evidence suggests that the Qwerty keyboard, somehow selected by the market, is not worse than any other alternative.

In conclusion, also in the New Economt markets can properly balance the short run and long run interests of consumers better than policymakers: promote innovation, enable an efficient degree of interoperability and select the best standards.

A lot of the residual contrast between Microsoft and the European Commission depends on the approach to interoperability and on its ambiguity. The Commission's March 2004 antitrust decision mandated the licensing of intellectual property to enable full interoperability between Windows PCs and work group servers and competitor products. This mandate has turned out to be the most problematic in the case: the picture that is emerging from Brussels is of a Commission that has continued to extend the scope of the information required, while not spelling out exactly what would constitute compliance with the remedy. As Mastrantonio (2006) has pointed out, “this bias towards `full interoperability' could be quite dangerous. Indeed, in the event that the imposition of a too broad restriction on its `exercise' would be deemed as `necessary' or that an infringement is not furnished of the `minimum of proof' but notwithstanding the Court imposes a remedy, the Authority will inevitably end up giving a direct judgement on the `existence' of the property right in question and legal certainty will break apart while innovative effort will be jeopardized.” It would be better to leave the ruling of intellectual property protection and of its limits to the legislative level rather than creating the precedent for which antitrust authorities could force firms to reveal their IPRs.

Nevertheless, at the time of writing, Microsoft has been forced to licence more than a hundred technologies (and in 2006 has even made available to its competitors access to the

source code of Windows): nevertheless in Europe not one of its competitors has taken out a license, a likely sign that the existing level of interoperability is not as low as it was depicted.

5. CONCLUSIONS

In this last article we reviewed the main implications of the theory of market leaders for competition policy with particular reference to the markets of the New Economy. On this basis, we studied a particular market of the New Economy, the software market, characterized by a clear market leadership, that of Microsoft, through the lenses of the economic analysis previously developed. The purpose of this discussion was not to provide arguments in support of one or the other position, but to suggest that the role of leaders in dynamic markets of the New Economy can be quite different from the role of leaders in traditional markets. The same role of Microsoft in the software market could be re-evaluated as that of a Stackelberg leader in a market with endogenous entry along the lines of our theoretical discussion.

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