MICROSOFT EUROPE CASE:
THE REFUSAL TO SUPPLY INTEROPERABILITY

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Abstract

The present work provides an economic analysis of the Microsoft Europe Case, and in particular of the part which concerns the refusal to supply the required protocols for the interoperability between personal computer operating systems and work group server operating systems. In particular, the anti-competitive conduct adopted by Microsoft (as an incumbent monopolist in the first market) is examined through a strategic perspective, in order to illustrate the incentives for the incumbent to provide or deny compatibility between its own product and competing versions of the complementary product. For this purpose, the work extends some dynamic interactions, previously considered in tying models, to the issue of interoperability between complementary products, in a market characterized by strong network effects, as it is the software market.

The perspective adopted by the European Commission on this case was an essentially static one: it consisted in asking how Microsoft's profits would change if it did or did not engage in the exclusionary practices it was accused of, assuming that the rest of the market structure remained the same. But, as it results from a dynamic analysis of the concerned markets, the exclusionary practice followed by Microsoft had two facets: excluding rivals from the work group server operating systems market and defending its core business – the market for PC operating systems. A consideration on the future evolution of the software market and an evaluation of the entry threat in the PC operating systems market show how the incentive to deter entry in the latter market was in fact for Microsoft a determinant reason for denying interoperability, as it can be inferred also from some analogies with the features of the exclusionary conduct observed in the US Microsoft Case.

JEL classification: K21, L12, L41

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Hent Kalmo and Alessandro Scopelliti

1. Introduction

Microsoft Corporation, known as the producer of Windows, the most widely used operating system for personal computers, has been the object of several antitrust procedures both in Europe and in the US, because of its very large – near monopolistic – market share, and specifically for its monopolistic business practices towards consumers and its discriminatory strategies against competitors.

The first Microsoft case in antitrust policy was started by the US Department of Justice in 1998, after several complaints regarding alleged antitrust violations by Microsoft in the PC operating systems market and in the browsers market (1). In particular, the following points were raised: first, the maintenance of monopolization in the market of Intel-compatible PC operating systems, through various anti-competitive conducts, like exclusionary provisions in licensing agreements with original equipment manufacturers, as well as exclusive dealings with internet access providers; secondly, the tying of the Windows operating system with Internet Explorer, which had a foreclosing effect towards the other competitors in the browsers market, in particular Netscape Navigator.

In Europe, the first antitrust case against Microsoft (known as "Microsoft Europe") was promoted by the European Commission, which adopted an infringement decision in March 2004 for abuse of a dominant position (art.82 TEC) and imposed the largest fine ever in European competition policy, € 497 million. The decision stated that Microsoft had abused its dominant position in the PC operating systems market in two ways: by deliberately restricting inter-operability between PC Windows and non –Microsoft work group server operating systems; and by tying Windows Media Player with Windows operating system. This decision by the European Commission was later confirmed by the Court of First Instance in September 2007, following an appeal lodged by Microsoft.

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(1) For an analysis of the US Microsoft case, see Evans D. S., Nichols A. L. and Schmalensee R. (2001), *An Analysis of the Government's Economic Case in U.S. versus Microsoft*, Antitrust Bulletin; see also Fisher F. M. and Rubinfeld D. L. (2000), *United States versus Microsoft: An Economic Analysis*, in Evans D.S., Fisher F. M., Rubinfeld D. M. and Schmalensee R. (2000), *Did Microsoft Harm Consumers? Two Opposite Views*, AEI Brooking Center for Regulatory Studies

In January 2009, another Microsoft case was started by the European Commission, regarding the tying of Internet Explorer with Windows, framed in terms very similar to the previous US case.

2. Microsoft Europe and the refusal to supply inter-operability information

In the present paper, we will focus on the Microsoft Europe case, and, in particular, to one of the two aspects concerned: the refusal to supply inter-operability information regarding Windows PC operating system to other producers of work group server operating systems, such as Sun Microsystems. We are interested in examining the inter-operability issue rather than the tying of Media Player, because the analysis of this particular conduct allows us to study a peculiar aspect of the anti-competitive strategy followed by Microsoft in the last few years: it tends to monopolize other adjacent markets for two simultaneous reasons, both for the gain arising from extending its market power to another complementary product, and for defending, in a forward-looking perspective, its monopoly in PC operating systems against potential competition in that market.

In order to explore the coexistence of these two incentives in Microsoft's conduct and for understanding the framework of the case, it is necessary first to analyze the structure of the relevant market. Two are the relevant markets considered in this case.

The first one is that of PC operating system software (2), so let us specify what it really means. In the text of the decision, the operating systems were defined as "system software products that control the basic functions of a computer and enable the user to make use of such a computer and run application software on it". In the analysis of demand-side substitutability, the European Commission mentioned also the distinction between client PC operating systems for Intel-Compatible and for non Intel-Compatible PCs (for example, Apple Macintosh), given that a client PC operating system designed to run on an Intel-compatible PC cannot run on a non Intel-Compatible PC unless it is modified and vice versa. But, differently from the US Department of Justice (3), the EU Commission left open the question whether the relevant market for Microsoft

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(2) Some interesting insights on the specific issues of software market are discussed in Katz M. L. and Shapiro C. (1998), *Antitrust in Software Markets*, in Eisenach J. A. and Lenard T. M. (edited by) (1998), *Competition, Innovation and the Microsoft Monopoly: Antitrust in the Digital Marketplace*, Kluwer Academic Publishers

(3) The US Department of Justice limited the definition of the relevant market to the OS for Intel-Compatible PCs on the basis of a demand substitutability consideration. As suggested by the results of the SSNIP test (Small but Significant Non-transitory Increase in Prices), a price increase of Windows would not significantly induce consumers to switch to MAC OS, because of the costs of acquiring new hardware and compatible software applications, as well as for the effort to learn the new system.

included only OS for Intel-Compatible PCs, given that the answer didn't really influence the outcome of the assessment of its market power.

Indeed, in the discussion of supply-side substitutability, the Commission pointed out that the production of a PC operating system presents increasing returns to scale, given that almost all the costs for producing such software are fixed costs due to the development of an initial or new version of it. Then, while these fixed costs are very high, once the initial version has been developed and tested, the marginal cost of producing an extra copy is very low. Such fixed development costs also explain the existence of an important barrier to entry for other firms potentially interested in supplying a new operating system.

In the market for PC operating systems (defined without any distinction for PCs), Microsoft had a market share higher than 90%, both in units of product and in revenues, which was persistent over time and even increasing in the last few years. Then it had a strongly dominant position in the market through its Windows products (4), as it was also acknowledged by Microsoft (5).

The second relevant market is that of workgroup server operating systems. In the Commission's decision they were defined as "operating systems designed and marketed to deliver collectively file, print and group and user administration services to relatively small numbers of client PCs linked together in a small to medium-sized network". This definition clearly shows the importance of interoperability between workgroup servers and personal computers, given that the services provided by the first ones are targeted for the second ones.

Microsoft also supplies workgroup server operating systems, where it faces competition from a set of other vendors with their own proprietary technologies. But, at the same time, Microsoft's PC operating system near-monopoly gives it control over the proprietary protocol specifications that allow a PC to interoperate effectively with a server operating system, then building an additional (artificial) barrier to entry. This peculiarity of Microsoft's position also explains the rapid rise of its share in this market: indeed, while it had a market share equal to 55.6% in unit shipments and to 54.7% in revenues in 2000, just two years after, its market share was equal to 66.4% in unit shipments and to 65.7% in revenues. Moreover, it is important to remark that this

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(4) Usually, market share is one of the elements considered in the assessment of the market power for the analysis of a dominant position, together with some other aspects, such as the existence of entry barriers, the technology used by the competitors, the degree of excess capacity held by rival firms, the time persistence of a certain pattern. But clearly, in this case, the presence of such a high market share was enough for proving the market power of Microsoft, which is of course strengthened by other factors.

(5) For completeness, it must be said that in a first stage Microsoft contested the application of the traditional approach for market definition and assessment of market power to the new economy's industries, characterized by an exponential growth in technology level, able to determine a rapid evolution of market structure.

11% increase of Microsoft's market share in workgroup server operating systems from 2000 to 2002 was contemporaneous to the launch of a new version of Microsoft Windows, that is Windows 2000. In fact, many of the already limited disclosures that had been undertaken by Microsoft with respect to Windows NT have been discontinued with the development of Windows 2000. This empirically shows the negative correlation between the level of supply of interoperability information on Windows PC operating system and the size of Microsoft's market power in the workgroup server operating systems. Then it is clear how Microsoft could easily improve this market power in the adjacent market, simply by reducing the disclosure of interface protocols on Windows PC.

On the basis of the high market shares, but especially in consideration of the links between the PC operating systems market and the workgroup server operating systems market, the European Commission concluded that Microsoft had a dominant position also in the market for workgroup server operating systems.

The market structure discussed until now is that one described in the decision of the European Commission. But the rapid evolution of the software market is likely to modify very soon some of these features, in particular as far it concerns the role of servers in providing services to the personal computers (6), in such a way to compromise even the function of the PC operating systems. Indeed, if the past quarter-century was characterised by a decentralisation of computing, with information processing and storage placed on every desktop and laptop, the coming era will bring greater consolidation of computing power in "clouds", or large-scale, distributed computing facilities. The economies of scale arising from consolidating computing in fewer places, and the availability of fast internet connections that make it easy to exploit these internet-based resources definitely explain this change. The consequence of this evolution is that, for many consumers, it will be possible to use these services simply by connecting a simple handheld device or an inexpensive laptop to the web, rather than by employing a powerful computer running Microsoft Windows or Apple OSX operating systems. In this way, the transformations of the software market could significantly reduce the importance and the utility of the PC operating systems.

3.1 The decision of the European Commission

On the basis of the previous description of the concerned markets, it is now possible to briefly recall the contents of the decision, in particular as far it regards the remedies imposed with

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(6) An interesting explanation of these future evolutions is provided in the following article: Financial Times, *Cloud Control*, 26th March 2009.

reference to Microsoft's conduct (7). Indeed, exploiting its dominant position in the PC operating systems market, Microsoft had refused to supply the protocol specifications related to the Active Directory in Windows, which were requested by competing stand-alone vendors of server operating systems, and in particular by Sun Microsystems, or had done so on discriminatory terms. That had produced the effect of reducing the interoperability of competitors' products with its dominant Windows PC operating systems.

The Commission therefore required, as a remedy, that Microsoft should draw up detailed lists of protocol specifications to enable third parties to interconnect with Microsoft Windows client and server operating systems. The way the Commission justified a duty to license was the following:

1) Microsoft's conduct was part of a general pattern of conduct, including another abuse (tying of Media Player);

2) Microsoft discriminated by supplying certain vendors but not others;

3) Microsoft ended past disclosures of interoperability information;

4) Microsoft's conduct determined a risk of elimination of competition on the server OS because interoperability information was of "significant competitive importance" and there are no substitutes for Microsoft's providing this information;

5) a duty to disclose the specifications did not affect Microsoft's incentives to innovate, since source code information would not be disclosed.

3.2 Microsoft's incentive to monopolize work group server operating systems market

In order to understand the reasoning of the Commission, it is important to keep in mind that, the Commission attempted to demonstrate that three conditions had been fulfilled (8). First, Microsoft had an incentive to expand its market power from client PC operating systems' market to the adjacent work group server operating systems' market. But this was not enough. The Commission also had to prove that Microsoft's conduct (i.e. refusal to disclose information on interface) is an effective means to eliminate competitors. In addition, the elimination of competitors in the work group server OS market must have been harmful to consumers.

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(7) For a discussion of the Microsoft Europe case, in the general framework of the refusal to deal, as a category of the abuse of dominant position, see O'Donoghue R., Padilla J. (2006), *The Law and Economics of Art.82 EC*, Hart Publishing, in particular chapter 8. For the problems related to the refusal to license intellectual property in EU competition policy, especially in the Microsoft Europe case, see Korah V. (2006), *Intellectual Property Rights And the EC Competition Rules*, Hart Publishing, in particular chapter 8

(8) See Lévêque, F., «Innovation, leveraging and essential facilities : Interoperability licensing in the EU Microsoft case", World Competition, March 2005, pp. 14-15.

In our discussion, we will concentrate on the first of these considerations, i.e. the issue whether Microsoft had an incentive to leverage its dominance from client PC operating systems' market to work group server operating systems' market and whether its conduct can be explained by a wish to exclude potential entry into the operating systems' market for personal computers. For the applicability of the models that follow, it is important to note that operating systems for client PCs and operating systems for servers are complements for some customers and substitutes for other customers.

They can be complements because the value for consumers of a client PC operating system increases when the quality of the work group operating system increases and vice versa. Such complementarity is, however, not relevant for all consumers because some of them never connect their PC to a workgroup server. But operating systems for PCs and servers are also substitutes for some customers because there are functions that can be integrated either into the client PC operating system or into the workgroup server operating system. The presence of customers for whom the two operating systems are substitutes is crucial for the argument, offered by the Commission, that the two products need not be used in fixed proportions. This argument was presented to reject Microsoft's claim that, according to the one monopoly profit, it had no economic incentive to extend its dominance to the work group server OS market.

3.3 Microsoft's single-monopoly-profit defence

As said above, in the course of the proceedings, Microsoft contested that it had an incentive to monopolize the server OS market. To buttress this claim, it relies on the single monopoly profit theorem. The gist of this theorem is that a monopolist of two complementary products gains nothing from extending its market power from one product to the other: it is already in a position to extract the entire surplus that the joint use market generates.

In order to see more precisely how this theorem may have supported Microsoft's case, let us suppose that a firm X is a monopolist of good A that costs c_A to produce and that a consumer values at level v_A. Assume that there is also a competitively supplied product B with a unit cost c_B that is valued at v_B. Now, the consumer will only purchase a bundle of the two goods if $P_{A,B} < v_A + c_B$. Obviously, in this kind of market, the monopolist can do no better than earning $v_A - c_A$. But that is the level the monopolist earns selling A independently. Once again, the idea behind the single monopoly profit theory is that, if two goods are complements, a firm who has monopolised the market for one of them, can extract all the profit by selling this product only. It has no incentive to leverage its dominance from one market to the other, because, given complementarity, consumers of the other product are already subject to its market power. Microsoft argued that this was

precisely the case here. Since it had an almost full control of the market for client PC operating systems, it apparently could not have increased its profit by dominating the market for server operating systems.

In fact, it could even have been argued that granting compatibility is beneficial to Microsoft. It ensures two types of gain. First, it could have strengthened its monopoly of client PC operating systems by multiplying the uses of this product. In addition, it could have contributed to the server market growth, from which Microsoft directly profits. Because of its monopoly, it could have set a royalty scheme that enables it to capture all the profit of the server OS market. In other words, Microsoft should be indifferent between getting money from its own sales of workgroup server operating systems and collecting royalties. Again, it would seem that it has no incentive to increase its share of the server OS market.

That was not the way the Commission saw things. In its submission, the Commission rejected Microsoft's claim that the one monopoly profit theory is relevant in this case. To expand the Commission's rather succinct remark, it is useful to list the assumptions that must hold for the theory to be applicable to the kind of market setting we study here. First, (1) as the Commission points out, the two products must be consumed in fixed proportions. In addition, (2) there must have been a perfect monopoly in the client PC operating systems' market, and, inversely, (3) perfect competition in the work group server operating systems' market. Finally (4), for the theorem to hold in this case, it must be assumed that Microsoft's monopoly in client PC operating systems' market was not under threat.

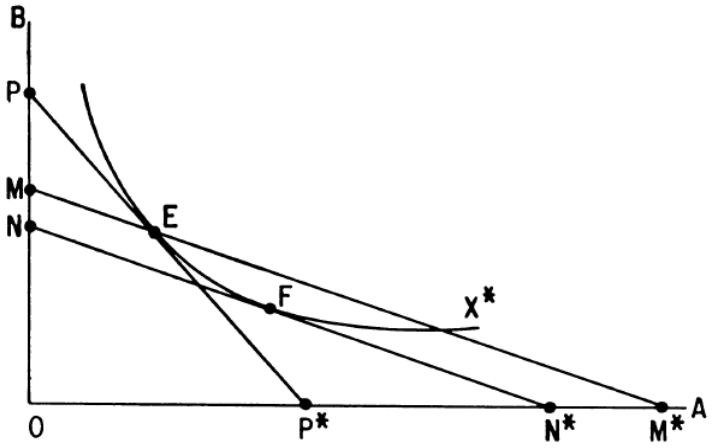
In what follows, we will examine the way Microsoft's incentives change when the above assumptions are not realized. We will keep the second assumption but will relax, in turn, all the others. First, we will offer a more explicit statement of the Commission's argument that, with variable proportions, the one monopoly profit theorem does not apply. We will then present two models that explore the implications of imperfect competition in the server operating systems' market and Microsoft's interest in defending its monopoly in the client PC operating systems' market - its core business.

3.4 Fixed vs. variable proportions

As we saw, one of the conditions that must hold in order for the one monopoly profit to be applicable, is that the two products must be consumed or used as inputs for production in fixed proportions. The Commission argues that, in the case at hand, this condition is not fulfilled: "For instance, a decision to invest in work group server operating system products may derive from a need to have a given number of users exchange and share more information, rather than from a need

to accommodate more users and may thus not be coupled with a decision to buy more client PC operating system products" (9). Although this is the example that the Commission uses, it is doubtful how relevant it is for the point at issue. What needs to be shown is that the same level of production (understood in a wide sense) can be achieved by using variable quantities of inputs. i.e. substituting one for the other. For the moment, we will therefore assume that there are customers for whom, as noted above, operating systems for PCs and servers are substitutes.

The one monopoly profit theory relies on the argument that there is a fixed surplus which is entirely captured by the monopolist, with or without entry into the adjacent market. However, if the two products are not produced or consumed in fixed proportions, the result ceases to hold. To see this, suppose that two inputs are required, A and B, which can be combined in variable proportions, so that a given quantity of the final product X can be produced with alternative quantities of A and B. The figure below shows the various combinations of A and B that can be used to produce a level of final output X*. Let us suppose that a firm has a monopoly over A. The question we want to answer is whether the monopolist can still extract all of the profit by an appropriate pricing scheme (as was true in the fixed-proportions case). Note that there is a crucial difference between the two cases: with variable proportions, as P, the price of A, increases, producers using the two inputs will substitute away from A and use more of B. This kind of reaction is not possible in the fixed-proportions case, because here, independently of the price of A, one input cannot be used to substitute for the other.



Source: Vernon and Graham, 1971 (10).

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(9) Decision, para 767, page 204.

(10) Vernon, J. M., Graham, D. A., « Profitability of Monopolization by Vertical Integration », *Journal of Political Economy*, Vol. 79, No. 4, p. 925.

In the figure above, NN is the isocost line, indicating the ratio of the price of A to the price of B, for the case where the price of A is set equal to its marginal cost. The point F represents the least-cost input mix for producing the level of output X*. Now, if the price of A is set above its marginal cost by the monopolist, the isocost line faced by the industry will have a steeper slope, such as PP*. Under these conditions, the industry will minimize its costs by picking the input mix represented by the point E. Because the industry's costs now include a monopoly profit, its expenditures on inputs exceed true resource costs (by the vertical distance MN, measured on units of B). Monopoly pricing thus imposes a deadweight loss by introducing a distortion: setting a monopoly price on A causes inefficient production (11).

Thus, with variable-proportions consumption, an attempt to extract the entire surplus by using the price of one product only, has the effect of reducing the surplus to be extracted. Controlling both markets, on the other hand, Microsoft could introduce efficient proportions and increase the total surplus. The conclusion is that, with variable-proportions technology, it is not anymore the case that Microsoft would not gain from refusing to grant interoperability with Sun's products. As the Commission points out, "the inadequacy of the premise invalidates, in turn, the allegation that Microsoft has no economic incentive to use any anti-competitive means to expedite such a result" (12).

3.5 Static vs. dynamic view

Until now, we have looked at the Microsoft case from a static angle. The question we have been asking is whether Microsoft would have immediate gains from refusing to grant interoperability to SUN. Although the one monopoly profit theory suggests that there would be no such immediate gains, and that Microsoft therefore would have no incentive to leverage its market power to the adjacent server operating systems' market, that result is true, as we saw, only if the two products are consumed in fixed proportions. But this way of setting up the problem suffers from a more fundamental insufficiency. It restricts us to an essentially static view of the case which consists in comparing Microsoft's profit under interoperability to its immediate profit under non-interoperability. If the latter is equal to, or higher than the former, then the conclusion appears to be that Microsoft does not stand to gain from the type of exclusionary practice that the Commission accuses it of.

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(11) Viscusi, W. K., Harrington, J. E., Vernon, J. M., *Economics of Regulation and Antitrust*, Fourth edition, Cambridge, Massachusetts, The MIT Press, p. 245.

(12) Decision, para 766, page 204.

This short-term perspective is, however, seriously truncated. It fails to take into account the long-term effects of Microsoft's behaviour. It may well be the case that Microsoft's refusal to enable interoperability has no immediate effect on its profits – as suggested by the one monopoly profit theorem – or even that, by so doing, it harms itself in the short-term, but this refusal can still be profitable if there are countervailing long-term gains. To start with, the market itself could be highly mobile, making monopoly power inherently precarious. For example, if A is a product that is linked (either by complementarity or substitutability) to product B, which is, in turn, linked to product C, shifting market power from A to B is an indirect way of extending domination from A to C. A firm could be a monopolist of product A and also compete with other firms in the sale of product B. Product C, that uses product B, then arrives and makes product A obsolete. In gaining a monopoly of product B through leveraging, firm A is able to capture the profit from the new market related to product C (i.e. leveraging from B to C). One possible explanation of Microsoft's behaviour is thus a desire to create a serial monopoly in a setting where contours of different inter-related markets are changing, influencing the value of dominating any individual market. Indeed, as mentioned in the introduction, the operating systems' market for client PCs, where Microsoft's position is the strongest, is predicted to rapidly change in a few years.

4. A model with fixed proportions

It was mentioned above that the results implied by the one monopoly profit hold only if the two products are not used in variable proportions. We will now, however, present a model - developed by Whinston (13) - in which the refusal to grant interoperability can be a profitable strategy for a monopolist even with fixed-proportions consumption. At that stage, we will keep that assumption of the one monopoly profit theorem. At this stage, we also continue to assume that there is a perfect monopoly in the client PC operating systems' market, and that this monopoly is not under threat. On the other hand, we will now abandon the assumption that the work group server operating systems' market has a competitive structure. We will assume, instead, that there is a duopoly so that the monopolist of the first market (A) is competing with another firm in the second market (B). That seems a realistic assumption in the present context. Considering that there exist important scale economies in the production of software for servers, it is not surprising that the Commission found the market to be in fact oligopolistic.

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(13) Whinston, M. D., « Tying, Foreclosure, and Exclusion », *American Economic Review*, Vol. 80, No. 4.

For modelling this kind of setting, let us suppose that there are two components that are needed to create a system: products A and B. Any single consumer needs one system only. We can interpret the 'system' as comprising an operating system for a set of personal computers and an operating system for a server that is used for servicing this set. Suppose that firm 1 is a monopolist of component A. Two different versions of component B are available: B1 and B2. Crucially, we assume that there is an alternative use for B, which does not rely on A. In the Microsoft case, that would mean that servers can be used not only for servicing personal computers, but for other purposes also. This appears to be a reasonable assumption as recent years have seen a rapid growth of internet-based applications for servers where the latter are directly linked to various hand-held devices without any need for a PC operating system. Another example of such independent use of server operating systems is upgrading of existing server software without a simultaneous purchase of software for personal computers. Because A is not needed for this use, firm 1 does not benefit from firm 2's presence in the adjacent market through increased sales of A and the logic of the one monopoly profit theorem breaks down (14).

We therefore assume that there are two types of consumers:

(1) A continuum of type I consumers who desire a system (A + B), indexed by the uniformly distributed variable $d \in [0,1]$ with total measure 1; The valuations of the consumer d for the products are the following: $v_{A/B1}(d) = w \cdot d$ and $v_{A/B2}(d) = w \cdot d + \gamma_1$ (w being a constant).

(2) Type II consumers, of which there is a total measure of θ, only desire B; Each type II consumer has valuations for products B1 and B2 of $v_{B1} = \varphi$ and $v_{B2} = \varphi + \gamma_2$.

It is assumed that firms are unable to discriminate across the two types of consumers in their pricing. Note that, if γ_1 and γ_2 are positive, then the version B2 is better than B1 in the sense of being valued more by both types of customers. The cost structure is the following: $c_A > 0$, $c_{B1} = c_{B2} \equiv c_B > 0$, $K_2 > 0$, $K_1 = 0$, where c is constant marginal cost. In words, we assume that both A and B have a positive variable cost and that an entrant into the market for B also incurs a positive fixed cost. We assume that firm 1 has no fixed cost although nothing much turns on this assumption and it is only made for expositional simplicity.

The game that firms 1 and 2 will play has three stages. In the first stage, firm 1 commits to which subset of three possible products it will be able to produce: (1) A interoperable with B2, (2) B1, or (3) B1 and A not interoperable with B2. Then, in the second stage, each firm simultaneously

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(14) Whinston, 1990, p. 854.

decides whether it will be active in market B. Finally, in stage three, the firms pick prices (simultaneously if both firms are active). If firm 1 is active in market B, it can offer three different items for sale: product A (interoperable with B2) at a price of P_A, product B1 at a price of P_{B1}, or product A (not interoperable with B2) and B1 at a price of $P_{A/B1}$. If firm 2 is active, it can only offer product B2 at price P_{B2}. For the results of the model to hold, it is crucial for firm 1 to be able to commit to the set of products it chooses to produce in the first stage. That could be possible because of technological constraints as firm 1 becomes locked into a production technology that allows it to produce only one subset of products. In the Microsoft case, that kind of constraints do not appear to be relevant. Nothing prevents Microsoft from releasing the information needed for interoperability at a late stage. We can nevertheless think of other mechanisms that would make commitment possible: most importantly, Microsoft's desire to build up or preserve a reputation for aggressive behaviour either in this or some other market.

The subgame perfect equilibrium outcome of the pricing game with interoperability, i.e. if the combination A + B2 is available on the market, is the following (15):

$$P_{B1}^{e} = c_B$$

$$P_{B2}^{e} = c_B + \gamma_2$$

$$P_{A}^{e} = \left[w + (\gamma_1 - \gamma_2) + c_A - c_B\right]/2$$

If there is interoperability, consumers simply respond to individual product prices and because the additional value attached to using the version B2 is γ_2, in the equilibrium, all consumers buying the product B, buy the version B2. Profits for the two firms are:

$$\Pi_1^{e} = \left[w + (\gamma_1 - \gamma_2) - c_A - c_B\right]^2 / 4w$$

$$\Pi_2^{e} = \gamma_2 \cdot \left[\theta + \frac{w + (\gamma_1 - \gamma_2) - c_A - c_B}{2w}\right] - K_2$$

Now suppose that firm 1 commits to not granting interoperability so that consumers cannot combine product A with the version B2. In this case, the unique subgame perfect equilibrium prices when firm 2 is active are:

$$P_{B1}^{e} = c_B$$

$$P_{B2}^{e} = c_B + \gamma_2$$

$$P_{A/B1}^{e} = (w + c_A + c_B)/2$$

(15) For a step-by-step resolution of the model, see Whinston, 1990.

with profits

$$\Pi_1^e = \left(w - c_A - c_B\right)^2 / 4w$$

$$\Pi_2^e = \gamma_2 \cdot \theta - K_2$$

Comparing firm 1's profits with and without interoperability, we see that there are two effects in play here. If γ_1 is greater than γ_2, firm 1's profits will be lower in the case it does not enable interoperability. Remember that γ_1 represents the additional value that type I consumers derive from combining A with B2 rather than B1. As for γ_2, we saw above that this parameter represents the additional value that type II consumer, i.e. a consumer who needs only product B, derives from consuming B2 rather than B1. Should firm 1 refuse to grant interoperability with B2, the first kind of surplus is obviously lost because A cannot, in this case, be combined with B2. In other words, firm 1 gains from interoperability because, if it produces an inferior version of product B, making A compatible with a competing version of B indirectly enhances the value of A itself. On the other hand, with interoperability, firm 1's sales of B1 were suffering because of the availability of a superior version of the product B. Its interoperability profit is a negative function of γ_2, the additional value that consumers attach to the competing version of B. By denying compatibility, it will make positive sales of B, i.e. to joint use customers.

Note that, as we would expect, firm 2's profits are smaller without interoperability. This is because, by committing not to grant interoperability, firm 1 can deny firm 2 its profitable sales to type I consumers, i.e. consumers who need both A and B. Firm 1 will have the means to bring this about because, although there exists an independent use for B, A is still essential for some uses of product B (16). By denying interoperability, firm 1 forecloses firm 2's sales in the joint use market. This will have the effect of lowering firm 2's profits and possibly forcing firm 2 to be inactive, depending on the value of the parameters. Whether firm 2 enters or not will, in particular, depend on θ, the total measure of type II consumers who need only B. But if indeed firm 2 chooses to be inactive, firm 1's profit will be $((w\text{-}c_A\text{-}c_B)^2/4w)+\theta(\varphi\text{-}c_B))$ where the second term $\theta(\varphi\text{-}c_B)$ represents the additional profits that firm 1 will gain from converting the market for B from duopoly into a monopoly: it will now be able to sell its version of B to θ type II consumers earning the margin $\varphi\text{-}c_B$ on every product sold.

The model presented above has been devised to explore the effects of bundling. Although it

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(16) Whinston, 1990, p. 854.

can also be used to evaluate Microsoft's incentives to grant interoperability, this change of interpretation introduces an important difference that should be kept in mind. A commitment to bundle carries a cost to the incumbent because, "having succeeded in foreclosing entry, the monopolist is now left to maximize profits over the two markets using only a pure bundle price" (17). That is not so in the Microsoft case. When the latter denies interoperability to its competitors in the server operating systems' market, it can continue to sell and price its products separately. The model does not of course demonstrate that Microsoft really had an incentive to refuse interoperability for exclusionary purposes. The only thing it shows is that it is possible that Microsoft has such an incentive. It also draws attention to some features of the market setting that the Commission should have paid more attention to: was there a difference in the consumers' valuation for the server operating systems that were on the market, to what extent had there previously been joint use of Microsoft's software for personal computers and others firms' software for servers, and most importantly, what was the share of customers who bought operating systems for servers only.

5.1 A dynamic leverage theory for compatibility decisions

The defence proposed by Microsoft, on the basis of the single monopoly profit theorem, presupposes another important but disputable assumption: the absence of threats to Microsoft's monopoly in the operating systems (OS) for personal computers. As explained in the introduction, with reference to the future evolution of the OS market, this assumption doesn't exactly correspond to the reality. Indeed, the development of new online servers, able to process and store information from clients' personal computers as well as to provide online services and facilities without the intermediation of PC operating systems, can in the future increasingly compromise the applications entry barrier that has guaranteed up to now the dominant position of Microsoft in PC operating systems market.

The applications entry barrier is a consequence of the network externalities characterizing the software market, which can be explained through a two-way reasoning: consumers are willing to buy a given PC operating system as it allows to run several applications and tend to value its utility depending on the number of applications developed for it; at the same time, the producers of PC software are interested in developing applications for the operating systems which are more

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(17) Stole, L. A., "Price Discrimination and Competition" in Armstrong, M., Porter, R. H. (eds.) *Handbook of Industrial Organization*, Volume 3, p. 2284.

widespread, in order to exploit the broadest possibilities for diffusion of their own products. In other words, the success of a PC operating system strongly depends on the quantity of applications that can be runned on it: this is the reason why the number of PC programmes developed for Microsoft Windows constitutes an entry barrier in the OS market. Indeed, possible entrants are discouraged from entry because, in order to acquire a significant market share, they need to convince software developers to produce applications for a new operating system not yet known to consumers. Then, if a platform available through a web browser, as Java through Netscape, can implement several applications independently from the usage of a specific PC operating system (18) or if an online server can process and store information from clients' personal computers without the need of a PC operating system, this can limit the importance of the applications entry barrier in favour of Microsoft in the software market. On the other hand, it can also reduce the size of the market for PC operating systems, simply because of the reduction in demand.

As argued above, this dynamic analysis of the future threats to Microsoft's monopoly in clients' PC operating systems market can provide a much more satisfactory explanation of Microsoft's incentives for expanding its market power to the workgroup server OS market than the static perspective which underlies the one monopoly profit theorem. The refusal to supply interoperability information to Sun Microsystems can be seen as a part of a general line of conduct aimed at decreasing the compatibility between Microsoft Windows and the workgroup server operating systems of other producers. It was a means not only for monopolizing another market, but especially for protecting Microsoft's dominant position in the PC operating systems market. Indeed, a determinant reason why Microsoft wanted to leverage its monopoly position to the workgroup server OS market was to fend off potential entrants to the PC operating systems' market, i.e. its core market.

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(18) This is the main issue in the US Microsoft case. In fact, it is often recalled as "The war of browsers", between Internet Explorer and Netscape Navigator, because through the decision to tie the browser Explorer to the operating system Windows, Microsoft managed to strongly reduce the market share of Netscape, initially the leading browser. Nevertheless, also in this case, the primary interest of Microsoft was not in browsers market, but in operating systems market. In fact, using this exclusionary practice against Netscape, Microsoft managed to limit the diffusion of Java, a middleware developed by Sun Microsystems, able to support software applications for multiple operating systems and then perceived by Microsoft as a threat to Windows as a platform for software development. In particular, thanks to an agreement with Netscape, Navigator became the main channel by which the Java runtime environment got access to the PC of Windows users. Then the integration of Internet Explorer (completely free) within Windows, even without the possibility to remove it, allowed not only to enlarge Microsoft's market share in the browser market, but especially to protect the dominant position of Windows in the operating systems market and then to deter entry in that one.

In light of these observations, Microsoft's conduct can be explained on the basis of a dynamic leverage theory, elaborated as an extension of the model proposed by Choi and Stefanadis (19). This is a model developed for analysing tying decisions with complementary products, and its purpose is to explain how tying can affect the investment incentives of entrants and buttress an incumbent's monopoly position. It offers a theoretical framework that is particularly useful for high-technology sectors, given that the potential entrant has to implement a risky R&D investment, but can enter the market only if this innovation effort is successful and makes it possible to develop a new technology. The probability of success depends also on random factors, but it is anyway an increasing function of the level of investments. Once the incumbent decides to tie two complementary products, given that it is a monopolist in one of them, the entrant can gain access to consumers only if an entrant in the other product is successful, or if it manages to enter both markets at the same time (20). In this way, tying makes the success of investment less certain, decreasing the entrants' incentive for investment and innovation.

In many cases of compatibility between complementary products, such as in the Microsoft case, the decision to deny interoperability can produce the exclusionary effect on the producer of one of the products in the same way as in tying models. To see this, let us consider a case where an incumbent operates in two markets, A and B, being monopolist in A and competing with other firms in B. As in the model we presented above, the incumbent firm, by refusing interoperability between A and competing versions of B, the incumbent can leverage its monopoly position to the market for B in order to foreclose rivals. But it can also fend off potential entrants into its own market. Consumers who need both complementary products – the joint users – are induced to buy the version of B that is produced by the incumbent, since this is the only version compatible with A, which they also need in order to build up a system (21). In this way, a linkage is created between A and the incumbent's version of B, which may be even stronger than in a tying case and, by way of consequence, more effective in foreclosing competitors. The exclusionary mechanism therefore is almost the same, especially if we consider as a term of comparison a tying decision with high commitment level, which creates a stable connection between two products.

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(19) Choi J. P. and Stefanadis C. (2001), *Tying, Investment and the Dynamic Leverage Theory*, The RAND Journal of Economics, Vol. 32, No.1, pp.52-71

(20) In the first case there are two independent firms, each of them interested in the market for one product; in the second case there is an integrated entrant, interested in both markets. As it will be clear from the following discussion, the second hypothesis can be more relevant from our point of view, for an application to Microsoft Europe case.

(21) Clearly, those who are interested only in B can buy it from the competitors, while those who need only A have to buy it necessarily from the incumbent.

5.2 The case of two independent firms

On the basis of the above observations, it is now possible to present the framework of a model. We will firstly analyze the basic model (22), with two independent firms, and then its extension to the case of an integrated entrant.

Let us consider 2 complementary products: A and B. Firm 1 is present in both products. It produces A_1 and B_1 at unit cost c_h each. In each of the two markets, there is a potential entrant that can sell products A_2 and B_2 (substitutes for A_1 and B_1). By making an investment in R&D in the amount of I_{i2}, each potential entrant obtains, with probability $p(I_{i2}) = \varepsilon + I_{i2}$ (with $\varepsilon < I_{i2}$) (23), a successful innovation (implying unit cost reduction from c_h to c_l). The cost of investment I_{i2} is equal to: $C(I_{i2}) = \gamma(I_{i2})^2/2$ where $\gamma > c_h - c_l$

We assume that the utility function of consumers is given by: $U_{Aj,Bj} = \vartheta - p_{Bj} - p_{Aj}$

Then the game is organized as follows:

1) Firm 1 decides on compatibility between A and B
2) Firms A_2 and B_2 take investment decisions
3) Active firms name price in a Bertrand competition.

Let us solve the game backwards.

Price Sub-Game

In the case of *no compatibility*, an entrant can operate in the market only if another entrant is successful, otherwise only the incumbent is active.

a) If only the incumbent is active, it sets a price ϑ and then it earns $\vartheta - 2c_h$

b) If both entrants are active, each sets a price c_h and then makes profits $c_h - c_l$

In the case of *interoperability*, a successful entrant in only one product can market it, then 3 situations can be considered.

a) If only the incumbent is active, it sets a price ϑ and then it earns $\vartheta - 2c_h$

b) If both entrants are active, each sets a price c_h and so makes profits $c_h - c_l$

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(22) In the analysis of the standard case, with two independent firms, we will follow the variant of Choi and Stefanadis (2001) which is presented in Motta M. (2004), *Competition Policy: Theory and Practice*, Cambridge University Press

(23) We assume that the probability of success depends more on the investment level than on random factors.

c) If only one entrant is active, there is a continuum of equilibria. The incumbent obtains a share λ of the innovation rent, with $\lambda \in [0,1]$, so its profits are $\vartheta - 2c_h + \lambda(c_h - c_l)$, while the entrant gets $(1-\lambda)(c_h - c_l)$.

Investment Sub-Game

Under *compatibility,* the profits by an entrant are:

$$\pi_{i2} = \{p(I_{i2})[1 - p(I_{k2})]\}(1-\lambda)(c_h - c_l) + p(I_{i2})p(I_{k2})(c_h - c_l) - C(I_{i2})$$

where the first term indicates the profits obtained when the other entrant is not successful, while the second term presents the profits gained when both the entrants are successful.

Substituting the functions for $p(I_{i2})$ and $p(I_{k2})$, as well as for $C(I_{i2})$, firm 2 maximizes the profit function with respect to I_{i2}. From the FOC, given that at the symmetric equilibrium $I_{A2}^* = I_{B2}^* = I_2^*$, the optimal investment is:

$$I_2^*(\lambda) = \frac{[1-\lambda(1-\varepsilon)](c_h - c_l)}{\gamma - \lambda(c_h - c_l)}$$

Under *no compatibility*, the profits by an entrant are:

$$\tilde{\pi}_{i2} = p(\tilde{I}_{i2})p(\tilde{I}_{k2})(c_h - c_l) - C(\tilde{I}_{i2})$$

At the symmetric equilibrium, the optimal investment is:

$$\tilde{I}_2^* = \frac{\varepsilon(c_h - c_l)}{\gamma - (c_h - c_l)}$$

A comparison between the optimal levels of investment in the two cases shows that $I_2^*(\lambda) = \tilde{I}_2^*$ only when λ=1. Otherwise, if λ<1, given that $\partial I_2^*(\lambda)/\partial\lambda < 0$, this implies that $I_2^*(\lambda) > \tilde{I}_2^*$. The optimal investment level under compatibility is equal to the one under no compatibility only when the incumbent gets all the innovation rent; then the entrant, since it doesn't get any profit, is induced to invest less. On the contrary, when the incumbent obtains only part of the innovation rent, the entrant has positive profit and then it is willing to invest more.

Interoperability Decisions

Under *compatibility*, firm 1's expected profits are:

$$\pi_1^*(\lambda) = \left[1 - \left(\varepsilon + I_2^*(\lambda)\right)^2\right](\vartheta - 2c_h) + 2\left(\varepsilon + I_2^*(\lambda)\right)\left[1 - \left(\varepsilon + I_2^*(\lambda)\right)\right]\lambda(c_h - c_l)$$

where the first term presents the profits that the incumbent obtains if it is the only firm active in both markets, while the second term indicates the part of the profits that firm 1 can obtain by extracting part of the innovation rent when one of the entrants is successful.

Under *no compatibility*, firm 1's expected profits are:

$$\tilde{\pi}_1^*(\lambda) = \left[1 - \left(\varepsilon + \tilde{I}_2^*\right)^2\right](\vartheta - 2c_h)$$

In order to decide whether to allow for inter-operability, the incumbent has to compare the expected profit in the two cases. The expected level of profits under compatibility depends on the value of λ, both directly through the second term, and indirectly through the value of $I_2^*(\lambda)$.

In particular, when λ=0, no interoperability is preferred as

$$\pi_1^*(\lambda) = \left[1 - \left(\varepsilon + I_2^*(0)\right)^2\right](\vartheta - 2c_h) \quad < \tilde{\pi}_1^*(0) = \left[1 - \left(\varepsilon + \tilde{I}_2^*\right)\right](\vartheta - 2c_h)$$

given that $I_2^*(0) > \tilde{I}_2^*$. Since each entrant can obtain the entire innovation rent, it is willing to invest a lot in R&D, then increasing its probability of success and decreasing the expected profit level of the incumbent.

On the contrary, when λ=1, interoperability is profitable because

$$\pi_1^*(1) = \left[1 - \left(\varepsilon + \tilde{I}_2^*\right)^2\right](\vartheta - 2c_h) + 2\left(\varepsilon + \tilde{I}_2^*\right)\left[1 - \left(\varepsilon + \tilde{I}_2^*\right)\right]\lambda(c_h - c_l) > \tilde{\pi}_1^*(1) = \left[1 - \left(\varepsilon + \tilde{I}_2^*\right)^2\right](\vartheta - 2c_h)$$

given that: $I_2^*(1) = \tilde{I}_2^*$. Since the incumbent can fully exercise a price squeeze thanks to its monopoly on one market and then profit from the increasing demand due to the complementary product, it is interested in allowing for compatibility.

So, in conclusion, there exists a value $\hat{\lambda} \in (0,1)$ such that $\tilde{\pi}_1^*(\lambda) \geq \pi_1^*(\lambda)$ for $\lambda \leq \hat{\lambda}$. It means that over (under) this threshold for λ interoperability is (is not) the profit-maximizing strategy for the incumbent. Then, in principle, we cannot say that the incumbent has always an incentive in denying inter-operability to the entrants. In fact, we can identify a trade-off for the incumbent in these decisions:

a) no compatibility decreases the risk of entry, then increasing its profits (exclusion effect);

b) no compatibility reduces the profit of the incumbent in presence of only one entrant (price squeeze effect).

Depending on which effect prevails, the incumbent determines the optimal interoperability strategy. But, in order to take this decision, it has to know before what price squeeze it can exercise on its product. If it is low, the incumbent would find optimal to deny interoperability. For instance, if there is not perfect complementarity between the two products, and then if some consumers are interested only in one of them, the increase of the demand for the entrant can only partially benefit the incumbent: indeed, if one entrant is active, the incumbent is able to obtain only a share (1-β) λ of the innovation rent, where β is the fraction of the consumers interested only in the product sold by the entrant. In particular, this example could be relevant in explaining Microsoft's conduct, because, as already considered in the previous model, some buyers of work group server operating systems are not interested in purchasing new versions of a PC operating system. If among all the

buyers of work group server operating systems the fraction of such consumers were to be quite substantial, this would significantly reduce the possibility for Microsoft to get a share of the innovation rents from the entrant and would reduce the profitability of the compatibility decision.

5.3 The case of one integrated entrant

After analyzing the case of two independent firms as entrants, we can now examine the extension of the model to the case of one integrated entrant (24), which can be more useful in order to explain the issue of interoperability decisions in the Microsoft Europe case. Indeed, from the viewpoint of Microsoft, as clarified in the defence behind the European Commission, the decision to deny compatibility was also justified by the fear that Sun Microsystem could use the required information in order to develop new products useful for entering the PC operating systems market. In fact, even if the request of disclosure didn't concern the source code of Windows, Sun Microsystem, as it was the developer of a middleware platform such as Java, could become in the future a potential competitor for Windows in the PC operating systems market (25). Moreover, it is important to remember that, before that request from Sun Microsystems, and for previous versions of Windows, Microsoft had already disclosed this type of interface information, for example through a previous license of information to AT&T. This would confirm that the refusal to supply the specifications of the protocols to Sun Microsystems was also due to the potential threat it could pose to Windows' monopoly in the PC operating systems market.

For this reason the idea of an integrated entrant can be appropriate to describe the role of Sun Microsystem in this game, given that it is at the same time the requester of the information disclosure for the development of a compatible workgroup server operating system, but also a potential competitor for Microsoft in the PC operating systems market.

In this version, the model follows the same sequence of the game and then is solved backward. For the price subgame, we refer to the standard version of the model, with the only difference that this time A_2 and B_2 are an integrated firm: so, when the investment of the entrant is successful in both products A_2 and B_2, this implies that firm 2 is active in both markets; while,

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(24) The case of an integrated entrant is also presented in the paper by Choi and Stefanadis (2001). But their theoretical framework presents the probability of success from investment in R&D in an implicit functional form. In our derivation, in order to derive explicit results for the optimal level of investment, we assume as before a linear functional form for this probability function.

(25) In this perspective, the Microsoft Europe case presents many similarities to the US Microsoft case.

when the investment is successful only in one of the products, then firm 2 is active only in that market. So let consider the optimal investment by the entrant and finally the interoperability decisions by the incumbent.

Investment Sub-Game

Under *compatibility,* the profits by the integrated entrant are:

$$\pi_{i2} = \{p(I_{i2})[1-p(I_{k2})]+p(I_{k2})[1-p(I_{i2})]\}(1-\lambda)(c_h-c_l)+2p(I_{i2})p(I_{k2})(c_h-c_l)-C(I_{i2})-C(I_{k2})$$

where the first term indicates the profits obtained when the R&D investments of the entrant are successful only in one product, while the second term shows the profits gained when the integrated firm manages to enter both markets. Firm 2 maximizes the profit function with respect to I_{i2} and I_{k2}.

From the FOC, given that at the symmetric equilibrium $I_{A2}^* = I_{B2}^* = I_2^*$, the optimal investment is:

$$I_2^*(\lambda) = \frac{[1-\lambda(1-2\varepsilon)](c_h-c_l)}{\gamma-2\lambda(c_h-c_l)}$$

Under *no compatibility*, the profits by the entrant are:

$$\tilde{\pi}_{i2} = 2p(\tilde{I}_{i2})p(\tilde{I}_{k2})(c_h-c_l)-C(\tilde{I}_{i2})-C(\tilde{I}_{k2})$$

where the first term indicates the profits obtained when the integrated firm manages to enter both markets (because of the denied interoperability, this is the only case where it can get a profit).

At the symmetric equilibrium, the optimal investment is:

$$\tilde{I}_2^* = \frac{2\varepsilon(c_h-c_l)}{\gamma-2(c_h-c_l)}$$

As before, a comparison between the optimal levels of investment in the two cases shows that $I_2^*(\lambda) = \tilde{I}_2^*$ only when λ=1. Otherwise, if λ<1, given that $\partial I_2^*(\lambda)/\partial\lambda < 0$, this implies that $I_2^*(\lambda) > \tilde{I}_2^*$. The optimal investment level under compatibility is equal to the one under no compatibility only when the incumbent gets all the innovation rent; then the entrant, since it doesn't get any profit, is induced to invest less. On the contrary, when the incumbent obtains only part of the innovation rent, the entrant has positive profit and then it is willing to invest more.

Interoperability Decisions

From the viewpoint of the incumbent, the case of one integrated entrant doesn't present any significant change in the expected profit function. Nevertheless, the interpretation of the equations is slightly different because of the existence of the same potential competitor in both markets.

Under *compatibility*, firm 1's expected profits are:

$$\pi_1^*(\lambda) = \left[1-\left(\varepsilon + I_2^*(\lambda)\right)^2\right](\vartheta - 2c_h) + 2\left(\varepsilon + I_2^*(\lambda)\right)\left[1-\left(\varepsilon + I_2^*(\lambda)\right)\right]\lambda(c_h - c_l)$$

where the first term indicates shows the profits that the incumbent gets when it is the only firm active in both markets, while the second term indicates the part of the profits that firm 1 can obtain by extracting part of the innovation rent when the entrant is successful just in one market.

Under *no compatibility*, firm 1's expected profits are:

$$\tilde{\pi}_1^*(\lambda) = \left[1 - \left(\varepsilon + \tilde{I}_2^*\right)^2\right](\vartheta - 2c_h)$$

which indicates the profits gained when the entrant, because of no interoperability, doesn't manage to enter any of the two markets.

In order to decide whether to allow for inter-operability, the incumbent has to compare the expected profit in the two cases. The expected level of profits under compatibility depends on the value of λ, that is the share of the innovation rent that it can appropriate through the price squeeze on the monopolized product.

So, the conclusions obtained for the case with two independent entrants can apply also in this framework. In particular, there exists a value $\hat{\lambda} \in (0,1)$ such that $\tilde{\pi}_1^*(\lambda) \geq \pi_1^*(\lambda)$ for $\lambda \leq \hat{\lambda}$. It means that over (under) this threshold interoperability is (is not) the profit-maximizing strategy for the incumbent.

What are the implications of this extension of the model for the analysis of the Microsoft Europe case? The main contribution consists in understanding the incentives that can influence the interoperability strategy of an incumbent firm, such as Microsoft, monopolist in market A and competing with other firms in market B, in the case that its monopoly in market A is under threat. In particular, for the purpose of the model, this threat has to come from a firm investing or operating in market B, which could be the case with Sun Microsystems. Indeed, the latter is a producer of work group server operating systems (product B), but it could be interested in entering in the future the market for PC operating systems (product A), also by using the know-how and the technologies already acquired through previous R&D investments in software market (think, for example, of the technologies employed for developing middleware platforms such as Java).

As the model shows, the incumbent could be interested in allowing compatibility of its product A with competing versions of B, in so far as it can increase its profit by getting a share of the innovation rent, when the entrant is active only in market B. In particular, we want to stress the importance of the last condition: the incumbent can exercise a price squeeze on product A, exploiting the increasing demand due to the complementary product B, provided that it keeps the monopoly on A. Indeed, if firm 2 were to be successful in both markets A and B, it would capture the entire demand for both products and then firm 1 would not obtain any profit at all. So, from the

viewpoint of firm 1, the decision to grant interoperability depends not only on the obtainable share of the innovation rent, but also on the probability of success of the integrated firm 2 in market A. This implies that the incumbent would not find it profitable to allow compatibility not only when the price squeeze margin is too low ($\lambda \leq \hat{\lambda}$), but also when the entrant has a high probability of success in market A (as exogenously determined by a high ε) (26).

Consequently, when firm 1 is worried about a possible entry of firm 2 in market A, it will prefer to deny interoperability, because in this way it can also reduce, even indirectly, the incentives of firm 2 for R&D investments in market A. Indeed, as we saw in the investment subgame, for any value of λ such that λ<1, the optimal investment under incompatibility is in any case smaller than the optimal investment under interoperability. This is because the integrated entrant knows that, in the case of no interoperability, it will obtain a profit only if it is successful in both markets, and obviously entering two markets is more difficult than succeeding in one of them: the joint probability $p(I_{A2})\ p(I_{B2})$ is always lower than the single probability $p(I_{B2})$, unless $p(I_{A2})=1$ (clearly, if this was the case, it would no doubt enter market A). Then, given that in the time sequence of the game the interoperability decision comes before the investment choice, the incumbent, by refusing compatibility, could induce a reduction in the investment level of the integrated entrant and, as a result, also decrease the probability of its success in market A (27).

The conclusions drawn from the model can easily be used to explain the present antitrust case: a typical feature of Microsoft's conduct, as also emerged in the US Microsoft case, is the propensity to implement discriminatory practices towards competitors as a defence against potential entry. Consequently, when it perceived a threat to its monopoly in the PC operating systems, and evaluated it as concrete (28) because of a significant probability of success for the investments by

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(26) If ε was defined as a random variable, firm A would need to know the expected value of ε in order to evaluate the exogenous determinants of this probability $p(I_{A2})$. But even if it was a constant, different for each entrant, the incumbent could have an asymmetric information problem, because it could find it difficult to evaluate the quality and the effectiveness of the research activity by the entrant, in terms of potential innovation outcomes, also because of the secrecy on its results. This information asymmetry could determine an overvaluation of this probability of success, then inducing the incumbent to deny interoperability just to defend its monopoly in A against eventual threats, even when the share of innovation rent obtainable under compatibility is quite high.

(27) Clearly, this doesn't mean that denying interoperability is enough for avoiding that firm 2 can implement successful innovations and then enter market A.

(28) This model doesn't include information problem in the analysis of the game. But, as suggested in note 18, the evaluation of the probability of success, at least for its exogenous component ε, can play a key role in the interoperability decision and then a further extension of the model could also introduce imperfect information, in order to study this type of interaction in a more realistic way.

the potential competitors, the profit-maximizing choice for Microsoft was to deny interoperability, in order to avoid that firms operating in the server operating systems market could in the future enter the market for PC operating systems. In other words, between the two alternatives of either granting compatibility and sharing the innovation rent of the entrant (but with a higher risk for its monopoly in PC operating systems), or refusing interoperability and foreclosing its competitors in both markets (but at the cost of renouncing to the additional profits due to the demand for the complementary product), Microsoft chose the second option. It adopted this aggressive conduct in order to anticipate and prevent the initiatives of possible entrants interested in the PC operating systems' market: in this sense, the idea to attack competitors instead of waiting to be attacked has frequently been implemented by Microsoft as a business strategy over the last few years.

6. Conclusions

The objective of this paper was to offer an economic analysis of the part of the Microsoft Europe case which concerned Microsoft's refusal to grant interoperability with its PC operating systems to competitors in the server operating systems' market. The decision of the European Commission in this case represents a very important milestone for the solution of refusal to deal issues in a rapidly evolving market, such as the software market: by imposing a duty to disclose the interface information related to Windows on Microsoft's competitors in the work group server operating systems' market, the Commission has implicitly considered the interface as an essential facility for the development of that market and has also established a duty for the incumbent to make available the interoperability information to its rivals.

What we can say in conclusion is that, although we agree with the outcome of the case, the reasoning of the Commission is not really exhaustive and fails to point out the exact way in which Microsoft would have gained from its exclusionary practices. The Commission was right to discuss at least some of the assumptions on which the one monopoly profit theorem is built. With variable proportions technology, the results implied by the theorem cease to hold and this part of Microsoft's defence consequently fails.

But what is completely lacking from the Commission's analysis is a dynamic and strategic perspective which reveals that, even if Microsoft would have had no immediate gains from its behaviour – or would have suffered short-term losses – it may have had a more indirect objective of excluding rivals. As the models presented above show, the strategy of deterring entry had two facets: excluding rivals from the work group server operating systems' market and defending its core business – the market for PC operating systems. The mechanism whereby the exclusionary

effect is achieved consists in reducing the rivals' expected profits or the optimal level of investments. Even if not granting interoperability apparently harms the incumbent itself, the objective is to deter rivals from entering, with an ensuing increase in the incumbent's profits.

The perspective the Commission adopts to evaluate the part of the case which concerns interoperability is an essentially static one: it consists in asking how would Microsoft's profits change if it did or did not engage in the exclusionary practices it is accused of, *assuming that the rest of the market structure remained the same*. But the models we presented suggest that Microsoft's incentives may have been related precisely to influencing the market structure: in the first case, to convert an oligopoly into a monopoly in the server operating systems' market, and in the second case, to maintain its monopoly in the PC operating systems' market.

Clearly, it does not follow from these models that Microsoft's behaviour in not enabling interoperability was *in fact* motivated by these strategic goals. That is not the conclusion we wish to draw. As far as the models go, i.e. without calibration, Microsoft may not even have had an incentive to refuse interoperability. It all depends on the value of the parameters. The conclusion is rather that the Commission should have paid more attention to the features of the market setting which the models imply were crucial: what was the share of consumers who only need operating systems for servers, what was the share of the innovation rent the monopolist could extract, etc. Only after a careful examination of these issues can it be said if the decision was in the end justified or not.