Microsoft Plays Hardball: The Use of Exclusionary Pricing and Technical Incompatibility to Maintain Monopoly in the Market for Operating System Software

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MICROSOFT PLAYS HARDBALL:

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* - MiCRA and all three of the authors have been retained by Novell and took an active part on behalf of Novell at the FTC during its recent investigation of Microsoft. The opinions expressed here are those of the authors, and not necessarily those of any other parties.

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I. INTRODUCTION AND SUMMARY

This paper examines Microsoft's licensing practices for its MS-DOS and Windows operating system software. We will focus on Microsoft's use of "CPU licenses." Under these licenses, an Original Equipment Manufacturer (OEM) of personal computers pays a royalty for each machine it ships instead of per unit of MS-DOS installed. In addition, these licenses impose a minimum requirements for the number of units of MS-DOS purchased. We also analyze the tying of supply of Windows and technical support information to the sale of MS-DOS, and attempts to induce technical incompatibility between MS-DOS and its main competitor, DR DOS.

We begin in Section II with a brief description of the market for personal computer operating systems in the early 1990's and a history of Microsoft's licensing practices and technical design tactics. In addition to CPU licensing, the minimum requirements contract, and the Windows tie to MS-DOS, this will include "cliff-pricing" quantity discounts for MS-DOS, and deliberate threats and attempts to create design incompatibilities between MS-DOS and DR DOS.

Section III presents the first of two potential efficiency rationales for the CPU license. This argument begins by observing that the CPU license exhibits characteristics of a two-part tariff. As such it may bring about first-degree price discrimination which may support efficient outcomes, as is often true for high fixed cost production. Upon closer examination, we find that the CPU license lacks the properties of first-degree price discrimination. More importantly, even if it were to act like a two-pat tariff, the CPU license would be not be welfare enhancing, and absent any exclusionary effect, it would also not be profit-maximizing.

Section IV examines a second potential efficiency rationale for the CPU license: it deters manufacturers from engaging in fraud, and it deters OEMs, retailers and customers from software piracy by reducing the number of "naked" machines shipped by OEMs. We conclude, first, that the prevention of piracy and fraud is not a plausible explanation for the historical introduction of CPU licensing. Second, the CPU license is not an effective way to deter piracy or fraud at least not when compared to non-exclusionary alternatives such as a "credited-CPU" license.

Section V turns to potential anticompetitive rationales for Microsoft's practices in the DOS market. We begin by observing that markets for many high technology products are characterized by a competitive process where a new product appears with a significantly superior technology or design and sweeps the field. By rapidly displacing the old product and its old technology, it achieves a very high market share in a very short time and earns very large profits. This situation persists only until the dominant firm is itself displaced by a new superior product. This cycle of a new product with a new technology displacing an existing product with an old technology is a process of "creative destruction" in the race to be best. Firms achieve a dominant position, but hold that position only temporarily. Even a monopoly firm and product can readily be dethroned by a competitor or a new entrant with a superior product. The exception, of course, occurs when that position is protected by strategically erected barriers to entry.

We examine the possibility that Microsoft has used exclusionary pricing and technical incompatibility to limit competition and to drive out rivals in the DOS market. We conclude that, under the conditions present in the operating systems market, such practices can be, and in this instance have been, effective in limiting the growth and threatening the existence of entrants and rivals with very small market shares. We also conclude that Microsoft's anticompetitive behavior reduced welfare.

II. BACKGROUND

A. MARKET FOR PERSONAL COMPUTER OPERATING SYSTEMS

Personal Computer Platforms. Our focus is on the market for packaged software that operates personal computers, and to a lesser extent, the software applications that run using those operating systems. To better understand the market for these products, we must delve into the economics and technology of the personal computer.

Several key features distinguish this product. Personal computers (PCs) can be decomposed into hardware and software components. Some of these components are essential:

every computer system requires a microelectronic chip called the Central Processing Unit (CPU) plus Operating System (OS) software. The OS directs the stream of instructions requested by the applications software, while the CPU performs the numerical computations. Importantly, the CPU and the OS are almost always combined in fixed proportions: one of each is needed per system.

Once an OS is installed, a user can run many kinds of applications software.[1] The most popular packages do word processing, spreadsheet analysis, and data base management. Increasingly popular is the use of a Graphical User Interface (GUI) that simplifies the management of the various applications. Both applications and GUIs are optional components of a personal computer system.

Personal computers are available in several "platforms" that differ in their hardware specifications. The predominant PC "platform" is the so-called "IBM-compatible" PC, which has evolved from the hardware and software specifications of the machine introduced by IBM in 1981.

The IBM platform is an "open system" meaning that outside suppliers can build hardware components and write software programs that are compatible with one another and with the original IBM design. In contrast, the Macintosh platform is closed; in particular, it runs on a strictly proprietary operating system.[2]

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[1] A PC also requires a layer of software that stands between the CPU and the OS. Called the BIOS, or Basic Instruction Operating System, this code is burned into the machine's ROM (Read Only Memory) chip.

[2] In the early years of the industry, Commodore, Tandy and Atari all had separate platforms that ran on proprietary operating systems. The Apple Macintosh platform is distinguished by being fully integrated: Apple Computer designs all hardware and manufactures it or contracts it out and supplies its operating system (Apple 2 in the early days, now System 7) and all applications through its Claris subsidiary.

Industry Structure. Despite the openness of the IBM platform, the supply of many components is highly concentrated. First of all, an overwhelming proportion of IBM-compatible PCs in use today are equipped with CPUs manufactured by the Intel Corporation. Secondly, the majority of existing PCs run on one version or another of the operating system sold by Microsoft Corporation. Sales of applications software and peripheral hardware components are far less concentrated.[3]

Hundreds of "original equipment manufacturers" (OEMs) assemble hardware components in various configurations called "models," distribute the machines through retail stores or mail order, and provide technical and repair service. In addition to a few large OEMs such as Compaq, Dell and AST Research in the U.S., and NEC, Toshiba and Hitachi in Asia, there is a host of small resellers. We can safely assume this segment of the market to be competitive.

The bulk of new PCs shipped in the U.S. (see Table 1) arrive loaded with some operating system, usually Microsoft's MS-DOS, and often with their Windows interface as well. IBM ships its PCs with one of its own operating systems: PC-DOS or OS/2. The only independent DOS (i.e., compatible with, but not a clone or derivative of, MS-DOS) has been DRI's DR DOS which, with Novell's acquisition of DRI in 1991, is now referred to as Novell DOS. Users can purchase OSs at retail stores (e.g., Egghead Software) or direct from the software publisher.

Demand for PCs. Personal computers are purchased by businesses, individuals, schools, government, and other organizations. Users select a hardware platform and a specific hardware-software bundle based on the overall system price. Accordingly, demand for an operating system as well as for the microprocessor is derived from demand for the entire package. In 1992, it was estimated that the worldwide installed base of personal computers of all platforms totaled over 138 million.[4] Of those, 72% were IBM-compatible. Less than a quarter of those machines were

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[3] As to the ROM-BIOS, there are many providers including Phoenix, AMI, Quadtel and Award in addition to IBM's original version.

[4] Bernstein Research, p.19.

equipped with Windows.

Potential purchasers of an operating system can be divided into two groups. First, there are existing PC owners seeking to upgrade their OS or switch to a new one. Then there are individuals who need an OS for a new machine, whether it is their first PC, a replacement, or an additional one. Either way, current OS users will bear some costs when switching from one OS to another. Certainly this would be true if the new OS demands a more powerful machine (as with the move from DOS to either Windows or OS/2). At a minimum, the user must learn some new command or menu structure and may have to replace outdated or incompatible applications.

Supply Conditions. Operating system software is very costly to develop and market. For instance, it has been estimated that the upgrade from Microsoft's Windows 3.1 to its new Windows NT will require a million lines of code,[5] and that IBM has spent over $2 billion developing OS/2. In comparison, operating system software is relatively cheap to produce and maintain. As a result, fixed costs are enormous and marginal costs are negligible. These fixed costs are also largely sunk. The code itself is rarely of little value in other uses.[6] Development teams accumulate expertise and reputation, only a portion of which can be re-deployed into other projects.

Entry into the operating systems software market is not easy. Barriers arise from the sunk costs of development and marketing mentioned above. Besides the irreversible investment in computer code, incumbents acquire sunk assets such as customer lists and brand name recognition. Furthermore, any new OS must conform to the dominant OS if they are to be compatible with all the applications that were written to that "standard." User switching costs

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[5] The Economist, January 27, 1993, p. 79 also claims that a typical word processing program half that size occupies 20 full-time programmers for 2 years.

[6] This may change as operating systems adopt the object-oriented approach in which the program is composed of "objects" that can be re-used in other programs in a modular fashion. NeXT Computer's operating system, NextStep, has pursued this strategy.

also limit the ability of new entrants to gain a toehold. Of course, these costs erect barriers only when the incumbent firm has a first-mover advantage. However, sunk costs ordinarily imply a first-mover advantage, at least for the current vintage of technology.[7] In addition, as we will see, IBM bestowed a somewhat unique first-mover advantage on Microsoft when it selected MS-DOS to be the operating system for its PC.

History of PC Operating Systems. Dating back to 1976, Digital Research Incorporated (DRI) sold a popular operating system, called CP/M, for use on machines based on Intel's 8-bit 8080 chip. In 1980, in what may become the deal of the century, Microsoft paid a mere $100,000 for the rights to a CP/M derivative or clone software package called "Disk Operating System," which, with minor modifications, became the initial MS-DOS. In 1981, when IBM launched its entry into the personal computer market, it selected Intel's new 16-bit 8088 chip as the CPU. It also chose to endorse Microsoft's MS-DOS as the operating system.

IBM's partnership with Microsoft later fell apart. Neither IBM nor DRI stopped developing their operating systems.[8] Under the terms of the dissolution, IBM continued to develop MS-DOS, and eventually its own variant, PC-DOS, which it loaded on PCs bearing the IBM nameplate. In exchange, IBM agreed to pay Microsoft a royalty for a pre-determined number of units.

Having been passed over by IBM, DRI went on to modify CP/M for the Intel 8086 chip, leading to its CP/M-86. Later it developed DOS PLUS and then DR DOS. In April 1990, DRI introduced DR DOS 5.0 to critical acclaim. Instantly, it began to make inroads into MS-DOS

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[7] If there are no cost complementarities across vintages of technology, then the requirement to sink substantial investment in software development will not convey an advantage to the successful first generation firms in the competition to develop subsequent generations of technology.

[8] There were two other significant MS-DOS derivatives. For a while, Compaq Computer had shipped its machines with its own Compaq DOS, and NEC developed NEC-DOS, a proprietary operating system that, until recently, dominated the Japanese market.

4.0's market share. By year end 1990, DR DOS's share had increased to 10% of new OS shipments, leaving MS-DOS with 70% and IBM with 18%.[9]

Within a month of DR DOS 5.0's inauguration, Microsoft reported development of MS-DOS 5.0. Curiously, it boasted nearly all of the innovative features of the DRI product. Yet MS-DOS 5.0 was not commercially available until July 1991, more than a year after DR DOS 5.0's release. Anticipation of the new Microsoft product, prolonged by continuous Microsoft statements indicating imminent availability, however, reined in growth of DR DOS 5.0 sales.[10]

The emergence of the graphical interface played an important role in the events that followed. After repairing bugs in Windows 3.0, Microsoft shipped Windows 3.1 in April 1991. In that year, 18.5% of new PC shipments included Windows along with MS-DOS. By 1992, that fraction jumped to 59.7%. Over that period, sales of MS-DOS (both with and without Windows 3.1) rose 28.9% while sales of PC-DOS and DR DOS fell 15.4%. (See Table 1.)

B. MICROSOFT'S PRACTICES

The CPU License. When first available, MS-DOS was sold to OEMs for a flat fee. Microsoft offered an unlimited number of copies for $95,000, and for a limited time, reduced the price by half.[11] Around 1983, Microsoft began to gear its license fees to the level of OEM sales. Then and now, each OEM contract was individually negotiated; an external price list never existed.

Over time, Microsoft phased in a new type of royalty contract. By 1992, the "CPU

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[9] Bernstein Research, Exhibit 2.

[10] Paul Sherer, "Microsoft outlines *DOS 5.0* to ward off *DR DOS*," PC Week, October 22, 1990.

[11] Manes and Andrews (1993), p. 12.

license" became the dominant sales arrangement. Under its terms, affiliated OEMs were required to pay a royalty for every CPU they shipped. Since each machine had a single CPU, the OEM paid for a copy regardless of whether the machine was pre-loaded with MS-DOS.[12] Microsoft would sell DOS licenses to OEMs who refused the CPU license, but only at significantly higher prices.

Under the CPU license, an OEM usually had to also commit to a minimum "requirement" (X) that approximates its annual shipments. The one-time charge for this requirement is computed using a negotiated per-unit price (f) multiplied by X.[13] If an OEM shipped a machine with a competing operating system, say PC-DOS or DR DOS, *it would receive no reduction in its payment to Microsoft.* Consequently, an OEM who accepts a CPU license faces a zero marginal price for units of MS-DOS up to the minimum requirement. In the event an OEM exceeded its projected volume during the contract period, the per unit fee (f) used to calculate the lump sum payment for the first X units would apply to each unit above X. Thus, once the contract is in place, the marginal price is 0 up to X units and f for additional units.

Regardless of whether an OEM ends up shipping more or less than X PCs during the contract, the terms of the CPU license commit the OEM to purchase MS-DOS for each PC it ships. As a result, customers view themselves as paying double if they use other OSs. If an OS competitor offers to sell at a per-unit price m, the OEM will only buy if the second OS has a quality advantage over MS-DOS valued at m or more.[14]

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[12] CPU licenses are reportedly being applied to the sales of software other than MS-DOS, such as Windows for Workgroups. [REFERENCE?]

[13] It is paid to Microsoft over the course of the year with an initial payment at the beginning of the year.

[14] For a competing OS supplier to make a sale to an OEM who has signed the CPU license, the quality differential must be worth at least m regardless of whether the OEM is shipping more or less than X PCs. When the OEM ships less than X units, her marginal cost of using MS-DOS on the next PC is zero, compared with a marginal cost of m if she chooses another OS. After X PCs have been shipped, the marginal OS cost is f if the OEM uses MS-DOS, and it is $f + m$ if the OEM uses the other OS. In each case, the additional marginal cost of using the

In 1992, the average license fee per copy of MS-DOS to a hardware OEM under these CPU licenses has been estimated at $15, far below the average retail price of an upgrade of $49.[15] All together in that year, Microsoft grossed $399 million on worldwide sales of 18,525,000 units of MS-DOS to OEMs and as upgrades.[16] From every indication, the implicit per-unit charges and requirement levels vary across the contracts signed by different OEMs.

Typically, these agreements ran for a period of two years. It was quite likely an OEM will finish any contract with unused licenses--if only because Microsoft, in an attempt to lock-in customers, would offer a lower per-unit fee to OEMs who agreed to minimum volumes exceeding expected shipments. The customer has no right under the contract to receive a credit for its unused units at the end of a contract. Nevertheless, Microsoft may allow the OEM to carry forward its unused licenses from the prior year Y.[17] When Microsoft allows carry forward of unused copies, then the marginal price of MS-DOS in the current year is effectively reduced by its implicit rebate value.

In addition to the price incentives for exclusivity that are provided by the CPU license, Microsoft has been reported to have responded with a variety of direct penalties if an OEM shipped some of its machines with a competing operating system. First, the OEM may be prohibited from carrying forward unused MS-DOS licenses. At the extreme, Microsoft has on occasion required an OEM to renew the CPU license at equal or higher volumes to retain the carry-forward option. In this way, Microsoft's policy on carry forwards establishes a "tie" between sales from one year to the next.

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alternative DOS is m. If the machine is shipped "naked," then m is zero.

[15] Bernstein Research, p.12.

[16] Bernstein Research, Exhibit 3. In that year, Microsoft's sales of Windows through OEM and upgrades totaled $599 million.

[17] Whether the unit is marginal or inframarginal, its value is the reduction in next year's CPU license fee from displacing one unit--after discounting for time and likelihood that the additional unit will be used.

Second, Microsoft's technical service and support may be withheld from the rebellious OEM. This practice can disadvantage an OEM who needs this information to match the hardware configuration with the demands of the operating software (especially the choice of the microprocessor, the amount of RAM, and the graphics card).

Third, the price of Windows have been increased to rebellious OEMs. As far back as the days when Windows was called Interface Manager, Microsoft established a connection between the terms of sale of MS-DOS and its graphical interfaces.[18] Microsoft cautioned OEMs against bundling competing multi-tasking interfaces (such as Quarterdeck's DESQview, VisiCorp's VisiOn and DRI's GEM) with PC hardware components such as hard disks.

Discounts on Windows were extended to OEMs who agreed to accept a CPU license for MS-DOS. Those who refused the CPU license or who did not use MS-DOS exclusively, could still purchase Windows. Again, Microsoft extended the nearly valueless option of purchasing it on an unbundled basis for a much higher per-unit price.

What options are open to an OEM who does not wish to exclusively ship its machines with MS-DOS? The OEM can negotiate a per-unit contract with Microsoft. However, Microsoft charges a price differential that is so high relative to CPU rates as to make the per-unit "option" economically infeasible. Alternatively, the OEM can choose not to deal at all with Microsoft. In that case, it can purchase on a per-unit basis[19] DR DOS or OS/2 (assuming the OEM manufactures machines that fit OS/2's higher memory requirements). Or it could send out machines with no operating system at all. A user who buys a "naked" machine must obtain an OS from another source. The owner can transfer the operating system from an old machine, buy a new copy from a retail outlet, or "pirate" one from another user or an electronic bulletin board.

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[18] Manes and Andrews (1993), pp. 14-15.

[19] The CPU license appears to be unique to Microsoft. Besides DRI's per-unit license, UNIX is sold to OEMs such as Sun Microsystems using right-to-use "site" licenses. Like most site licenses, they provide for volume discounts.

TABLE 1: NEW SHIPMENTS OF PERSONAL COMPUTER OPERATING SYSTEMS

COMPANY	OPERATING SYSTEM	1990	1991	1992
Microsoft	MS-DOS	11,648	13,178	18,525
	w/ Windows	490	2,440	11,056
	w/o Windows	11,158	10,738	7,469
IBM	PC-DOS	3,031	3,003	2,315
DRI/Novell	DR DOS	1,737	1,819	1,617
DOS Subtotal		16,603	18,288	22,847
Apple	Macintosh	1,411	2,204	2,570
UNIX	UNIX	357	582	797
IBM	OS/2	0	0	409
Other	NEC, etc.	5,079	4,628	4,458
TOTALS		23,450	25,702	31,080
Source: Bernstein Research, International Data Corporation				

Technical Incompatibilities. Coordination on technical standards is crucial between the OS developer and applications developers. In several instances, Microsoft made it difficult for competitors, especially DRI/Novell's DR DOS, to achieve compatibility with Windows. Nowhere is this coordination more important than with the publication of the APIs. Microsoft has left undocumented some of these interfaces. In principle, access to these APIs would allow Microsoft to write applications (such as for its Word word processor or its Excel spreadsheet) that work faster and with greater functionality. Furthermore, should an applications developer discover and choose to use these undocumented interfaces, as long as they remain "unofficial," Microsoft can remove or alter them in later versions of the operating software, rendering parts of the applications useless.

One way for applications programmers to ensure compatibility with an operating system is to receive copies of the preliminary version of the software. Known as "beta testing," this gives applications developers an opportunity to fine tune the interaction between the two programs.

In a well-publicized episode, DRI was excluded from the beta testing of Windows 3.1 and later Microsoft's Windows for Workgroups product. The importance of compatibility testing with the Windows beta version became evident when applications developers using DR DOS received error messages warning them of a potential incompatibility with Windows. As it turned out, upon installation, Windows 3.1 checked whether the source of the underlying system and the extended memory manager was a Microsoft product. If they were not, the user was informed that a problem was detected, and was asked to contact Microsoft's beta support for Windows 3.1. This message appeared on the screen even though no actual compatibility problem was detected. Indeed, if the user continued past the alleged error message, he or she would discover that Windows 3.1 would run in conjunction with DR DOS. "The only error was that the customer was running Windows on a competitor's version of DOS."[20] The error messages raised fears of incompatibility among developers and users who contemplated running Windows with non-

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[20] Ibid., p.15.

Microsoft versions of DOS. Concerns over possible incompatibility between DR DOS and Windows resulted in significant declines in DR DOS retail sales. In addition, Windows disks included a "Readme" text file that cautioned users that "running Windows 3.1 with an operating system other than MS-DOS could cause unexpected results or poor performance."[21] Microsoft refused to address compatibility problems with DRI.[22] Microsoft boldly defended its action claiming it had no responsibility to assist an operating systems competitor.[23] Microsoft's actions went beyond refusal to assist a competitor, however, as it had engaged in commercial sabotage.

Antitrust Action. Microsoft's practices first came to the attention of antitrust authorities in Korea. The Korean Fair Trading Commission launched an investigation that centered on use of the CPU license in Asia. In May 1992, the Korean FTC banned the use of CPU licenses in that country.[24]

In June 1990, the U.S. Federal Trade Commission initiated an unofficial investigation of Microsoft's practices. At first the focus of its inquiry was the relationship between Microsoft and IBM and the statements being made by these companies about their future OS product development. Later the investigation turned to marketing practices of DOS and Windows.[25] Without ever acknowledging the investigation, the Commission met in February 1993 to decide whether to issue a unprecedented preliminary injunction requiring Microsoft to cease and desist from its marketing practices. The vote was a 2-2 tie.

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[21] Wendy Goldman Rohm, "Will the FTC come to its senses about Microsoft's mischief?" Upside, August 1993, pp. 11-27.

[22] PC Week, August 12, 1991.

[23] Microsoft's decision was clearly related to market power. It provided Windows beta versions to many of its competitors in applications software where, at the time, it was not a dominant firm.

[24] Jenifer Phang "Microsoft Deals Not Fair: Korea," Asia Computer Weekly, May 11-17, 1992.

[25] At one time, the FTC entertained the option of divesting Microsoft's operating systems and applications divisions, or at least establishing separate organizations.

After a second deadlock six months later, the Commission transferred the case to the Department of Justice where it is under consideration today.[26] About this same time, Novell filed a complaint against Microsoft with the European Commission. Once again, it asked for an end to CPU licensing and the Windows tie.

III. FIRST DEGREE PRICE DISCRIMINATION vs. INEFFICIENT SUBSTITUTION

At first glance it may appear that the CPU license is just a means to provide volume discounts to large OEMs. This is not the case: it is possible that an OEM that purchases more MS-DOS pays a higher per-unit price than one that purchases fewer units. This would happen if an OEM purchased more units of MS-DOS than some another OEM, but proceeded to ship many more machines (loaded with an alternative DOS or none at all). It is possible that its per-unit cost of MS-DOS could be higher because its royalty charge is based on the number of machines shipped.[27]

In fact, CPU licenses may imply a quantity premium if units beyond the requirements are sold at a per-unit charge. At the minimum requirements quantity, the marginal price jumps from zero to a positive level. So based on marginal prices, purchases beyond the requirements level incur a quantity premium.[28]

The CPU license could be characterized as first degree price discrimination only in a very limited sense. An OEM who signs under the CPU license (or a take-or-pay license with X >

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[26] [REFERENCE NEEDED.]

[27] The actual price paid per unit could be higher even if the royalty fee itself incorporated volume discounts.

[28] Average price is the more typical yardstick for measuring nonlinearity of prices. In the case of a CPU license, they fall through the range up to the minimum requirements and thereafter may rise or fall depending on whether the average price at the requirements level is lower or higher, respectively, than the per-unit charge for additional sales.

output) has agreed to a lump sum payment, with an (expected) zero marginal price for one year. However, since the size of the lump sum payment is based on expected sales times a per unit royalty, the OEM knows that if its sales increase, the (apparent) lump sum payment next year will also increase proportionately (based on the per unit royalty Microsoft will be charging in the next year). Thus, for any time horizon longer than one year, the CPU license is a tax on output; it is not first degree price discrimination.

A. FIRST DEGREE PRICE DISCRIMINATION

But even if---perhaps within the very limited time horizon of a one-year window---OEMs regarded the CPU license as imposing a lump sum fee unrelated to their MS-DOS use or to their output, such a royalty structure would be neither profitable to Microsoft nor would it be welfare-enhancing when compared to a per-unit royalty.

Efficient first-degree price discrimination occurs when a seller charges a two-part fee, consisting of a lump sum payment for the right to purchase the product and a price for each unit equal to marginal cost. Where, as here, marginal cost is essentially zero, first degree price discrimination requires a per-unit price of zero.

Economists have long recognized the strong efficiency advantages of first-degree price discrimination when customers are final consumers so that their demands are independent. But these results do not hold when intermediate inputs are sold to competing downstream firms. In that case the demands of such customers (the firms in the downstream industry) are clearly not independent (i.e., if my rivals pay less for an input than I do, the price of the final product falls, reducing my demand for the input). Ordover and Panzar state the issue quite clearly.[29]

> *...we recast the welfare analysis of the simple two-part tariff using the classical model of perfect competition in which all firms are identical and free entry and*

[29] See Ordover and Panzar (1982).

exit ensures that the equilibrium output price is equal to minimum average cost. In this context we discover that two-part tariffs are not generally desirable from a welfare standpoint...This is due to the fact that the entry fee, instead of acting as a "lump sum levy," affects both the equilibrium number of firms and their output level. This new distortion must be balanced against the losses due to a unit price in excess of marginal cost. (pp. 659-660.)

However, where, as here, the input (OS) is used in fixed proportions with the output (PCs), and the downstream industry is a classic competitive industry with U-shaped average cost curves, Ordover and Panzar find that a very strong theoretical result obtains: a monopoly seller of the input would find any two-part tariff, including an all-or-nothing arrangement where marginal cost to the buyer is zero, less profitable than a uniform per unit fee. In addition, the uniform per unit fee results in higher economic welfare than any two part tariff. As Ordover and Panzar put it,

Most surprisingly, for the empirically relevant class of production processes in which the purchased input is required in fixed proportion to output, we discover that a two-part tariff is never optimal from either a profit or welfare maximizing standpoint. (p. 660.)

The intuition behind this result is rather straightforward. It is well known that under fixed proportions an upstream uniform pricing monopolist can extract all the profits which an integrated uniform pricing monopolist could reap. Since competition downstream ensures that a uniform price prevails in the final product market, there can be nothing to gain from introducing a two-part tariff; optimal choice of [the per unit price] allows the monopolist to earn the maximum possible under such circumstances. There is something to lose, however, since an entry fee $e > 0$ causes the downstream firms to operate at an inefficiently large scale. Total (upstream plus downstream) costs are not minimized and a portion of this dead-weight burden falls on the monopolist. Viewed another way, this result reveals

> *the futility of attempting to impose a seemingly nondistortionary lump-sum levy e on a perfectly competitive industry with free entry and exit.* (pp. 666-667.)

In short, even if Microsoft's CPU license did impose a true lump-sum payment, there would be no efficiency or welfare gain that could provide a defense for such a pricing system. Nor would such a licensing system be profitable for Microsoft to impose on OEMs even if those OEMs somehow did not recognize the link between their sales and the lump-sum royalties they paid. Both theory and the available evidence would indicate, therefore, that Microsoft's CPU license is not a form of first-degree price discrimination.[30]

One might ask if, in the context of this case, the fixed-proportions assumption made by Ordover and Panzar refers to fixed proportions between the OS and the PC, or does the result require fixed proportions between MS-DOS and the PC?[31] It does seem safe to assume that every PC requires one (and, as a practical matter, only one) OS. Every PC may not, however, require one MS-DOS although again, as a practical matter, given the pricing and tying arrangements

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[30] It could be argued that the Ordover and Panzar analysis is too long run, and that what Microsoft is really attempting to do is expropriate some of the fixed, sunk costs OEMs have committed. There is no obvious gain in economic efficiency from such behavior. More importantly, for Microsoft to do this, it would have to (1) estimate the fixed sunk costs of every manufacturer at the time DOS was first offered, and set a different lump-sum fee for every manufacturer that was less than that manufacturer's sunk costs, (2) convince the manufacturer that the lump-sum fee would not change if that manufacturer produced fewer or more PCs (3) set a zero license fee for DOS to any manufacturer who entered the PC market after DOS came on the OS market, and (4) set an average price for MS-DOS to the more established, larger OEMs that have expended significant sunk costs in differentiating their product that is significantly higher than the average price to smaller, "generic" OEMs, such as, notably, many of the Taiwanese and Korean OEMs. Conditions (1) and (2) would appear to be difficult to achieve. Condition (3) does not hold since Microsoft has not waived the CPU requirement for new OEM entrants. Finally, Microsoft appears to be charging the larger, more successful OEMs a lower - rather than higher - average price for MS-DOS in contradiction with Condition (4). Thus this possible argument for Microsoft appears to have no merit, either on policy or factual grounds.

[31] Note that fixed proportions implies that the input is essential, but an input can be essential without fixed proportions: an input is not essential if the unit cost of output approaches a finite limit as the price of the input approaches infinity.

imposed by Microsoft, most OEMs appear to have no practical alternative to MS-DOS over any relevant price range.

Recall, however, how the fixed-proportions assumption affects the results of the model. Absent fixed-proportions, the lump-sum fee is still inefficient, it is just that the per-unit-MS-DOS royalty alternative becomes less desirable. The analysis of the effect of the lump-sum royalty is only affected by alternatives to MS-DOS if those alternatives were such close substitutes that an increase in the lump-sum fee would not impose any cost on the OEM. That is, a lump-sum fee of any size would cause all OEMs to switch over to the alternative OS.

With fixed-proportions of MS-DOS per PC, a per-unit-MS-DOS royalty would not affect the MS-DOS to PC ratio. Thus a positive fee per unit of MS-DOS would not result in inefficient input proportions, making a per-unit-MS-DOS royalty as socially efficient (or inefficient) as a per-unit-PC royalty. This is in contrast to a lump-sum fee that would lead to, in the final market equilibrium, a distorted ratio of fixed to variable inputs, with too few firms, each producing too much output.

Suppose, instead, that there are fixed proportions between having some OS and a PC, but not having MS-DOS and a PC. In that case, a per-unit-MS-DOS royalty could result in the OEM shifting to some other OS. Would this be inefficient? Only if the social cost of the OS alternative (in this case DR DOS) were higher than the social marginal cost of MS-DOS. But since the social marginal cost of both DR DOS and MS-DOS (and indeed of all OSs) are equal (and nearly zero), this change in the ratio of MS-DOS per PC does not introduce an inefficiency.

We thus conclude that sufficient conditions for the Ordover and Panzar result are that either (a) the particular input - in this case MS-DOS - is used in fixed proportions with the final product, or (b) the social marginal cost of the alternative DOS chosen in response to an increase in the per-unit price of MS-DOS is less than the social marginal cost of MS-DOS.

This implies a natural extension of the Panzar-Ordover result. Suppose that the quality-

adjusted social marginal cost of the input(s) B, C,...toward which a manufacturer would substitute if the price of input A were increased is less than the quality-adjusted social marginal cost of input A. This appears to be true in this case, since the production cost of both MS-DOS and DR DOS are the same, while DR DOS is of arguably higher quality than MS-DOS. Production efficiency will then actually increase as a result of the higher per-unit-price for MS-DOS. It follows that, under these circumstances, a per-unit-MS-DOS royalty would be socially even more efficient than a per-unit-PC royalty.

B. INEFFICIENT SUBSTITUTION

While the CPU license does not produce a positive output effect (i.e., encourage efficient utilization of a zero-marginal-cost input), it does have a significant substitution effect. The CPU license induces substitution of MS-DOS for OS alternatives, notably DR DOS. While this may be privately profitable, the social gain is zero, even if it does not induce the exit of DR DOS with its attendant expected effects on raising the MS-DOS license fees. Both MS-DOS and (assuming its continued presence) DR DOS have a near zero social marginal cost in use. Thus, to the extent that the CPU license induces substitution of MS-DOS for DR DOS, no cost saving results.[32] Indeed, if, as appears to be the case, the value of DR DOS is greater than that of MS-DOS (at least on those PCs where DR DOS would be incorporated, absent the CPU license for MS-DOS), the substitution of MS-DOS for DR DOS actually reduces efficiency and total welfare.

IV. ANTI-FRAUD AND ANTI-PIRACY RATIONALES FOR IMPOSING CPU ROYALTIES RATHER THAN MS-DOS UNIT ROYALTIES

In this section we compare CPU royalties and per unit royalties in terms of their effects on fraud (underreporting of volume by OEMs) and piracy (unauthorized copying by end-users).

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[32] This is, of course, just another example of the theory of the second-best.

A. REDUCING MANUFACTURER FRAUD

As a factual matter, we are not aware of any evidence that underreporting of MS-DOS usage by PC manufacturers is or has ever been a serious problem. This is not to say however that in principle a CPU license could not reduce fraud. OS systems are duplicated and incorporated by the manufacturer, not the licensor, and only the manufacturer knows how many units have been duplicated. If the licensor could readily determine the total PC production of the manufacturer, a CPU license could effectively prevent such fraud. Several considerations, however, point to manufacturer fraud as not being the rationale for CPU licensing by Microsoft.

1. First and most important, we should observe CPU licenses where fraud is likely, but where market power or exclusion could not plausibly provide a rationale. If CPU licenses are not observed in those circumstances, then the ability of CPU licenses to minimize fraud is highly suspect.

Microsoft has historically chosen not to license many smaller and/or "high-risk" OEMs i.e., OEMs (mostly in Asia-Pacific) that are viewed as particularly prone to engage in fraud or whose demand levels might not justify the fixed costs of licensing. By contrast, DRI did license many of these producers, employing a variety of means to control potential fraudulent underreporting. These methods include the use of serial numbers cross-referenced to end-user requests for technical support, the use of holograms, and audits of the OEMs. If CPU licenses were an effective and inexpensive means of controlling fraud, DRI might well have used considered CPU licenses for these OEMs.[33] Beyond this, fraud is not a problem limited to operating system vendors, yet to our knowledge other software vendors similarly situated have not used such licensing terms. Thus, this market test indicates that CPU licenses are not part of the optimal anti-fraud strategy for a licensor of operating systems where market power and

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[33] DRI does not believe that the expense of an audit is affected, one way or the other, by whether one is auditing for violation of a CPU license or a per OS-unit license. Its business behavior confirms this belief.

exclusionary potential are not present.

2. Fraudulent underreporting cannot credibly be asserted for every OEM. Especially at the currently low royalty rates that would continue with competition from DR DOS, few, if any, of the major OEMs would have any incentive to defraud MS. Even if detection by Microsoft were unlikely, an OEM can be deterred[34] from fraud by penalties that are a correspondingly large multiple of the gains from fraud; Microsoft could clearly impose a penalty on a major OEM that would dwarf that OEM's potential gain from fraud. This implies that Microsoft imposes CPU licenses on many OEMs that could not credibly be expected to attempt to defraud Microsoft.

3. To our knowledge, Microsoft does not regularly "audit" the number of PCs produced. Rather, Microsoft relies on that manufacturer's representations of the number of PCs, just as they might have to rely on that manufacturer's representations of the number of PCs produced that incorporated MS-DOS.

One might argue that if an individual OEM's shipments of PCs can be accurately estimated, the use of CPU licenses reduces the need to engage in audits even if, given the decision to audit, there is no difference in auditing costs between CPU licenses and per unit licenses. Given that public information on OEM shipments shows considerable variation in estimated shipments for many OEMs, however, there is reason to question the empirical significance of such an argument.

There is, however, a plausible way to test this assertion, using information that, while not privately available, would be available to an enforcement agency such as the FTC or DOJ. What has happened to Microsoft's auditing expenses (per MS-DOS unit) since it introduced CPU licenses? If auditing expenses did not fall, this is inconsistent with CPU licenses being an

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[34] For example, the contract could specify treble damages (a three-fold royalty) for all proven cases of underreporting.

inherently superior method for dealing with OEM fraud.[35]

4. The timing of any shift between MS-DOS unit licenses and CPU licenses should parallel shifts in the seriousness of OEM fraud. To our knowledge, however, the introduction of CPU licenses did not coincide with any notable increase in the incidence or the potential for OEM fraud.

In particular, since an OEM's incentive to underreport is proportional to the size of the royalty, the extent of CPU licensing should have risen or fallen with the Microsoft royalty. This implies that, since the Microsoft royalty rate rose steadily until the availability of DR DOS induced a sharp decline, the prevalence of CPU licensing should have increased over time until DR DOS appeared, and then declined. In contrast, it is our understanding that widespread CPU licensing did not appear until early 1990, after the introduction of DR DOS and the ensuing decline in prices for PC operating systems.

5. OEM fraud could be handled by a credited CPU license, with the royalty based on the number of PCs minus the number of documented machines that were sent out either naked or loaded with some alternative OS system. Yet Microsoft's CPU licenses do not work in this fashion. Instead they require the OEM to pay a royalty on all machines produced, without a credit for the use of an alternative DOS.

6. Finally since, as noted above, an OEM's incentive to underreport is proportional to the size of the royalty, and since the availability of DR DOS has resulted in a sharp decline in Microsoft's royalty, it would appear that maintaining effective competition in the OS market has a desirable by-product -- it reduces the extent of OEM fraud.

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[35] The test is only a one-way test. If auditing expenses fell, this could be due to the reduction in the incentive for fraud (and, therefore, the reduced need to spend money to control it) after competition drove down the price of MS-DOS. This is discussed in points 5 and 6 below.

B. REDUCING THE NUMBER OF NAKED MACHINES IN ORDER TO REDUCE PIRACY BY THE OEM'S CUSTOMERS

Piracy of software by computer users has long been a concern of software developers. It has been alleged that CPU licenses may discourage piracy by reducing the relative benefits of installing an unlicensed copy of MS-DOS. By not installing any operating system on an outgoing machine, an OEM could pass along the saving to its customers. The OEM would sell more machines because at least some customers will prefer to install a pirated OS (and comparatively higher cost) rather than pay the additional cost to the OEM. This option is no longer attractive when the OEM faces a zero price for installing MS-DOS on a machine as is true under a CPU license.

There are, however, several difficulties with this proposition.[36]

1. Even before the advent of the CPU license, virtually no computers from companies licensed by Microsoft were shipped naked (i.e., without an OS).[37] Simply put, if the incidence of naked machines shipped by OEMs licensed by Microsoft was very low before CPU licenses, then it is not plausible that CPU licensing was implemented to reduce the shipping of naked machines.

2. Another major factor is that the OEM license fee is far lower than the retail price of MS-DOS. It might seem reasonable that individual users would pirate copies themselves (or buy commercially pirated copies of MS-DOS) if their alternative were a retail MS-DOS at a price

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[36] Note that the only form of piracy relevant here is an end-user's substitution of pirated MS-DOS for the MS-DOS incorporated by an OEM. In what follows, therefore, "piracy" refers to only this substitution, and not to the pirating of upgraded versions of MS-DOS by customers whose machines incorporated earlier version of MS-DOS. Such "retail upgrade" piracy could not be affected by a CPU license.

[37] This is not surprising, since there are good reasons to believe that it would be more expensive for most end-users to install an OS themselves.

of $79. But it seems inherently unlikely that many buyers of a new computer, no matter how much they may dislike paying for software, would go to such lengths to avoid paying less than $15 more on a $1,000 computer system.

3. A CPU license could only deter piracy if, absent the CPU license, the OEM would provide a discount for machines without an OS. If the customer pays the same price for a naked machine as for one with an OS installed, purchasing a naked machine cannot facilitate piracy. It is our understanding however, that OEMs did not generally offer a discount for naked machines prior to the introduction of the CPU license. If correct, then the CPU license could not have been a response to piracy. Moreover, even if prior to the CPU license, Microsoft's OEMs had been offering naked machines at a discount to end-users, Microsoft could easily have handled the problem by forbidding its OEMs from offering a discount for naked machines. While this might conceivably have raised some antitrust risk for Microsoft (under some private plaintiff's theory that the vertical restraint was unlawful), that antitrust risk would surely be far less than that associated with the CPU license. Thus, fear of antitrust exposure could not explain Microsoft's failure to adopt this simpler remedy, which would eliminate any incentive for end-user piracy while not foreclosing OS competition.

4. Microsoft could prevent the problem, if it exists, by charging a royalty based on the number of PCs that were sent out either with MS-DOS or without any OS or, if OEM fraud is also a problem, imposing a royalty based on the number of total PCs minus the documented number of machines that were sent out incorporating some alternative OS.

5. Since the customer's incentive to pirate will be proportionate to the amount of the OEM royalty that is passed on to him, it also follows that, as in the case of OEM fraud, a customer's incentive to pirate an OS will be proportional to the size of the OEM royalty. It would thus appear, again, that maintaining effective competition in the OEM market for operating systems has the desirable by-product of reducing the incentive for piracy.

6. If Microsoft is earning supra-competitive returns (i.e., risk-adjusted returns above

what would be necessary for the product to have been developed), piracy may be socially beneficial if it results in greater use of MS-DOS than would otherwise be the case. Output increases to some extent because some users of pirated MS-DOS might not otherwise have bought MS-DOS. A more important effect, however, is on the demand for MS-DOS becoming more elastic if piracy is possible since piracy is an increasing function of the price charged the OEM for MS-DOS. Thus even "deserving" customers -- those who would not or could not pirate an OS system -- gain from the existence of the pirates.[38]

Microsoft may object that tolerating piracy would inefficiently interfere with its ability to recover its investment in developing intellectual property. However, it is simply not the case that efficiency is greatest if property rights in intellectual property, at least as those rights are currently established, are perfectly secure. Most inventors are free-riding on a common pool of prior knowledge. In such circumstances, it can be shown that it is optimal for the inventor to face the same degree of free-riding on her invention. Perfect appropriability, in such circumstances, would lead to over-investment in inventive activity.[39] This observation seems particularly relevant here. Microsoft's original MS-DOS was based on its acquisition of technology from a company that had cloned CP/M, a pioneering PC operating system developed by DRI.

Thus we have an interesting policy paradox. The claim that CPU licenses help to control piracy is highly questionable when Microsoft earns monopoly returns on MS-DOS and there appears to be no efficiency rationale for the supra-normal returns. Were Microsoft earning competitive returns to MS-DOS, controlling piracy would clearly be defensible on efficiency

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[38] The situation is reversed, of course, in a competitive market, where pirating would only increase costs to non-pirating customers or even make some products unavailable.

[39] Barzel (1968) qualified Arrow's (1962) argument that imperfect appropriability leads to under-investment in inventive activity. For the proposition that the problems raised by imperfect appropriability may be significantly reduced if the existence of the product results in pecuniary and/or technological effects, see Jack Hirshleifer (1971). See also Spence's (1974, p.168) critique of Arrow.

grounds. Under the CPU license, however, the act that (allegedly) controls piracy also forecloses competition, thus also undermining the policy rationale for controlling the (alleged) piracy.

7. A similar debate over copying in other industries has made it clear that the effects of copying on profits and on social welfare are complex and ambiguous. The existence of "unauthorized" copying may actually increase the profits to the seller, and may be socially desirable, depending on the nature of infringing users and the heterogeneity of purchasers.[40] It is simply not clear that the CPU license would be in Microsoft's interest, absent its exclusionary effect on competition.

V. MARKET-POWER RATIONALES FOR CPU LICENSES RATHER THAN PER-UNIT ROYALTIES

A. WORKABLE COMPETITION IN TECHNOLOGY MARKETS WITH RAPID TECHNOLOGICAL CHANGE

Economic theory would predict highly volatile market shares under a set of conditions that

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[40] To illustrate the point, assume 1,000 homogeneous buyers, each with a reservation price for DOS of $100 for her main machine. Each buyer also has a second PC, onto which she can copy her purchased copy of DOS, for which the reservation price for DOS is $40 (alternatively, she has a younger brother, partner in her office, etc., to whom a pirated version of DOS would be worth $40). The marginal cost of DOS to Microsoft is $10, and the marginal cost to a "pirate" of unauthorized copying DOS is $15. If Microsoft effectively prevented copying (perhaps by inserting a secret virus that would destroy the disc if copied) it would set a price of $100, selling 1,000 units, with revenue of $100,000 and profits of $90,000. (If preventing copying were not cost less, profits would be less than $90,000). If Microsoft made no effort to prevent copying/piracy, it would set a price of $125 (= $100 + $40 - $15), selling 1,000 units for a revenue of $125,000 and profits of $115,000. Note that, in this example, anything that increases the cost to the "pirate" of unauthorized copying reduces the profits to the licensee. The point of this example is not that all copying/piracy benefits the licensee, but rather that even the private, much less the social, effects of copyright violation are complex and often ambiguous. For a thorough analysis of these issues, see Brennan (1986) and the articles cited therein.

have often characterized, to varying degrees, PC software markets. Consider a market where numerous potential entrants face no **ex ante** (Stiglerian) barriers to entry into the development of a new technology: entrepreneurs, usually scientists or engineers themselves, put together teams of scientists and engineers, financed internally from their past successes or from venture capital, with access to a common pool of basic technology and to learning acquired at their previous firm. These new firms incur significant sunk costs to develop a higher-quality technology that (we shall assume) is protected by laws that cover intellectual property to the optimal extent.[41] The new technology may be simply licensed to users (as to OEMs in the case of software) or embodied in a new product using manufacturing facilities available from a number of competitive firms (software duplicators and packagers for shrink-wrapped sales of software at retail). The products embodying these alternative technologies are mutually exclusive in the sense that a customer will almost always use only one operating system on any PC.

When two other conditions also hold, we would expect to observe a "competitive" or "socially optimal" performance. The first of these conditions is that firms in this market take their competitors' prices as given and unaffected by their own actions, and will thus continue to try to undercut their rivals' prices as long as that price exceeds their own marginal cost. The second condition is that homogeneous customers can costlessly switch between the products of rival suppliers.

Given these two conditions, we would expect to observe that: (1) a new technology or product will be developed if (and only if) the expected value of the costs of development is less than the expected value of the increase in the value to consumers of this technology over the prior technology, (2) the price of the old technology (e.g. the license or royalty fee) will fall to zero upon introduction of the new technology, (3) the price of the new technology will equal the difference in value between the old and the new technology, and (4) market share will rapidly

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[41] The optimal degree of protection for intellectual property - in particular, the optimal scope for patent or copyright protection in the computer hardware and software industries - is a matter of considerable debate that we cannot, unfortunately, enter into here.

shift from 100% for the old technology to 100% for the new technology.

While such competition may seem tough on the players, it (1) can still generate very large rewards to the winners, (2) results in even greater benefits to consumers: as each new generation appears, the value added by the prior generation is passed on directly to consumers,[42] and (3) is efficient in terms of production and distribution: a technology is developed if and only if it adds more value than it costs to develop, and that technology is priced, like all products in a competitive market, just below the marginal cost of its next best substitute (the prior technology) plus the value of the quality differential. The results under "perfect" competition thus provide a benchmark for evaluating performance in any particular case.

To the extent that these two conditions do not hold (e.g., because it is costly for consumers to switch), the old technology will retain some share at some positive price, and the new technology will sell at a higher price than the quality differential. If the new and the old technology are owned by the same firm, the implicit price of the old technology will not fall all the way to zero, although it may still be profitable for the firm to set relative prices so as to encourage migration to the new technology.

The resulting deviation from the pure model is not necessarily inefficient to the extent it reflects real costs of learning and equipment. But if owners of the current technology are allowed to create artificial barriers to the entry of a new technology, those suppliers will earn too much, opportunities for technical change will suffer, and consumers will be harmed.

One might expect something close to the result of the competitive model in operating systems because the industry appears characterized by **ex ante** (Stiglerian) barriers to entry that

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[42] In effect, firms earn a normal (i.e., competitive) return (adjusted for risk) on their investment, while the value of the underlying opportunity is passed on to consumers.

are low enough for these industries to be workably competitive, (absent exclusionary practices).[43] As a result, the incumbent would ordinarily expect only a limited time before a functionally similar or superior product becomes available. Given the combination of high fixed development costs and low marginal production and distribution costs, the resulting competition can have a dramatic effect on the profits of the first-mover. Not surprisingly, therefore, there is a strong incentive for the incumbent to try to make life difficult for any entrants, either by directly increasing their costs or by reducing the attractiveness of their product to consumers, and to do so as soon as possible.

Under certain conditions, it may be possible for a first-mover to maintain or even extend its dominant position through certain price and non-price strategies that seek to exclude or handicap its smaller rivals in dealing with its immediate customers. The goal of such a strategy, rather than to assist in achieving the original high market share (which requires having, at least for a while, the first-best technology), would be to artificially preserve that status. The four conditions described below appear to hold in the market for operating systems, where Microsoft successfully preserved an overwhelming market share against competition from a technically superior product--DR DOS. The conditions are:

1. Immediate buyers, i.e., firms at the next level downstream (e.g., OEMs), can be posed with an all-or-nothing choice by the dominant firm that compels them to deal either exclusively or not at all with the dominant firm;

2. While buyers would be interested in purchasing rivals' products for some of their requirements, they are unwilling to rely exclusively on those rivals' products: at least some of the dominant firm's product is very important or even essential to many or even all the downstream firms;

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[43] Entering a market with no Stiglerian barriers to entry may still be very difficult. Very large sunk costs of the magnitude observed for operating systems do usually imply a significant first-mover advantage, at least for the current vintage of technology. In addition, IBM bestowed somewhat unique first-mover advantages on Microsoft and Intel when it selected MS-DOS as the operating system and Intel's 8088 as the microprocessor for its PC.

3. The substitute product requires significant fixed sunk costs to develop, maintain or expand, so that some significant minimum market share is essential for entry or expansion; and

4. The costs to the dominant firm of forcing exclusivity on the downstream firms are relatively low.

B. MICROSOFT'S PRICING AND MARKETING STRATEGIES

Let us now turn to each of the four conditions for exclusivity to be an effective strategy against smaller rivals. The first condition was that immediate buyers, i.e., firms at the next level downstream, can be posed with an all-or-nothing choice by the dominant firm that compels them either to deal exclusively with the dominant firm or not at all. Here, Microsoft can effectively force OEMs that wish to incorporate MS-DOS in any of their PCs to use MS-DOS exclusively through either of two policies, both of which Microsoft has been accused of:

1. Microsoft can set per-unit MS-DOS prices that are so high relative to CPU rates as to make selecting the per-unit "option" economically infeasible: the OEM that wishes to use any MS-DOS will in effect be required to sign a CPU contract.[44] The CPU license (or a policy of inducing large carry-forwards) then provides a strong economic incentive (a zero cost to the OEM for using MS-DOS at the margin) for the OEMs to use MS-DOS exclusively;

2. Microsoft can also refuse to sell Windows to an OEM that purchases any alternatives to MS-DOS, and can cut off the OEM from technical information and other services provided to "favored" OEMs. This imposes a direct penalty on the OEM for using an alternative DOS in addition to the pricing incentive created by the CPU contract.

Our second condition was that, while buyers would be interested in purchasing rivals' products for some of their requirements, they are unwilling to rely exclusively on rivals' products:

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[44] Microsoft can also structure its Windows pricing to an OEM in such a fashion as to make it very difficult for OEMs to avoid a Windows CPU contract.

at least some of the dominant firm's product is very important or even essential to many or even all the downstream firms. In this case, OEMs are very reluctant to purchase DOS exclusively from sources other than Microsoft, at least in the short run, because:

1. Requiring a sudden and complete switch from one OS to another imposes real costs that could be avoided under a more gradual transition;

2. Actual or threatened technical incompatibility between other Microsoft products, such as Windows, and competing versions of DOS results in at least some of the OEM's customers insisting on MS-DOS;

3. Withdrawal of Microsoft support services to any OEM that does not enter into a CPU contract (or that purchases DOS from a source other than Microsoft) would impose what is in effect a lump-sum penalty for switching;

4. Microsoft can refuse to sell Windows to an OEM unless that OEM also purchases MS-DOS through a CPU contract.

Our third condition was that the substitute product requires significant fixed sunk costs to develop, maintain or expand, so that some significant minimum market share is essential for entry or expansion. In this case, given the large non-sunk fixed costs of remaining in the DOS market, any alternative to MS-DOS must either achieve a critical minimum market share, exit the market, or be subsidized indefinitely through other operations of the rival firm.

Our fourth condition was that the costs to the dominant firm of forcing exclusivity on the downstream firms are relatively low. Here, the cost to Microsoft of excluding rivals from the DOS market is very low as long as the share of those rivals remains very small, since:

1. The cost to Microsoft of requiring a CPU contract is that Microsoft may lose an entire OEM to a competitor. As long as MS-DOS remains essential, however, no OEMs will refuse the CPU contract, and the cost to Microsoft is minimal;

2. Similarly, the cost to Microsoft of tying Windows to MS-DOS is low. Microsoft sacrifices some sales of Windows to customers for whom the value of Windows is very low, but who would buy it to use with a rival's DOS but not with MS-DOS. But until a rival achieves a significant share of the DOS market, tying (or simply making Windows and any rival DOS incompatible) will again impose minimal costs on Microsoft.

VI. CONCLUSION

As compared with other strategies for maintaining market share, such as cutting prices or merging with entrants, implementing exclusionary practices can be a relatively cost-effective strategy to use against an entrant who has an superior technology but whose market share is very small. This approach can thus be characterized as a "fight them on the beaches" strategy, or less kindly, as "economic infanticide." The lower the market share of the rival, the lower the costs and the greater the benefits of this strategy to the established firm. Once--or if--the entrant reaches a critical market share, however, the incumbent can be expected to switch to the alternative defensive strategies or, if the entrant's technology is strictly superior and user switching costs are not significant, to simply abandon the field.

REFERENCES

Kenneth Arrow, "Economic welfare and the allocation of resources for invention," in National Bureau of Economic Research, The Rate and Direction of Inventive Activity, Princeton, NJ: Prince University Press, 1962.

Yoram Barzel, "Optimum Timing of Inventions," Review of Economics and Statistics, August 1968.

Timothy J. Brennan, "Taxing Home Audio Taping," Economic Analysis Group Discussion Paper 86-6, Antitrust Division, U.S. Department of Justice, April 15, 1986.

Bernstein Research, "FTC Investigation of Microsoft," Sanford C. Bernstein & Co.: New York, January 1993.

Jack Hirshleifer, "The Private and Social Value of Information and the Return to Inventive Activity," American Economic Review, September 1971.

Stephen Manes and Paul Andrews, Gates: How Microsoft's Mogul Reinvented an Industry--and Made Himself the Richest Man in America, New York: DoubleDay, 1993; cites are to edited and condensed version in "Microsoft Monopoly," Upside, March 1993, pp. 10-18.

Janusz Ordover and John Panzar, "On the Nonlinear Pricing of Inputs," International Economic Review, October, 1982, pp. 659-676.

A. Michael Spence, "The Economics of Internal Organization: An Introduction," Bell Journal of Economics, Spring 1974.