Chapter 9

New Modes of Competition

Implications for the Future Structure of the Computer Industry

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1. INTRODUCTION

Monopolization means changing industry structure to reduce competition. Preventing harm to competition is a worthy goal for antitrust policy, but a difficult one. Acts of competing themselves may affect industry structure and harm competitors. In many contexts it is quite difficult to reliably tell the difference between changes in industry structure because of monopolization vs. because of competition. These general guiding principles are familiar, but they apply with redoubled force in the computer industry. The computer industry has changed to new modes of competition, which we do not yet fully understand. The determinants of computer industry structure offer very powerful forces for efficient concentration and excellent opportunities for monopolization at the same time. There are only rarely opportunities for public policy to influence industry structure, and neither the appropriate policy goal nor the appropriate policy instrument need be obvious at those moments.

There is a consensus that the present may be one of those moments, and the future structure of the computer industry may be on the line. This paper provides an overview of the workings of computer industry competition and uses it to examine the likely efficacy of antitrust policy intervention.

My perspective is that of an industry economist. The first task is to understand how competition works in the industry, and how industry structure influences and is influenced by competition. Only when that task is done can we reasonably hope to say what kinds of industry structures public policy should favor and how. In computing, this task is made difficult by three factors. Technological competition, such as races to establish new standards and innovating to support new uses of computing, plays a very large role. Vertical competition or co-opetition, in which firms selling products which are complements compete with one another, is prevalent. Third, equilibrium is characterized by long eras of stable industry structure and stable standards punctuated by epochs of change in both. My analysis of these factors leads me to a framework for understanding computer industry competition.

In the second half of this paper, I use my framework of analysis of those factors and their influence on structure and strategy to examine the antitrust policy issues. None of these factors tells us the right direction for policy, despite empty-headed claims that a "new paradigm" favors either antitrust intervention or laissez faire policy. These factors simply make the always-difficult analysis of monopolization cases even more so. The available policy alternatives offer difficult tradeoffs between helping the market too early and helping it too little.

Looking at the actual state of competition in the computer industry leads me to frame the policy questions about a possible Microsoft monopolization case somewhat differently than other analysts. I ask, first, where antitrust policy stands among the likely influences on future industry structure. A reasonably compelling answer emerges that modest interventions (banning certain clearly anticompetitive practices, for example) will have very small impacts. Only quite substantial interventions (structural ones) are likely to be efficacious. I then ask how much market input from buyers should and can come into the determination of future industry structure. A reasoned case for intervention can be started, since it is easy to see an argument in which a no-intervention equilibrium process puts too little weight on buyers. It turns out to be quite difficult to complete the argument for intervention. The available policy alternatives offer difficult tradeoffs between helping the market too early and helping it too little.

The realities of computer market competition mean that the antitrust authorities should focus on long run technological competition. The goal should be to insure dynamic efficiency, not static efficiency in the present, because that is the only goal that can be pursued. The immediate policy subgoal should not be deciding which technology, industry structure, or other outcome is right. Instead, policy should attempt to maxing the influence of demanders in determining outcomes. That includes not only empowering demanders to choose a new alternative to the Microsoft standards, but also empowering them to keep the Microsoft standards over entrant alternatives should they choose.

2. THE ELEMENTARY POSITIVE ECONOMICS OF STANDARDS COMPETITION IN COMPUTING.

The relationship between computer industry structure and competition at first presents a puzzle. The puzzle is well captured by looking at Figures 1 and 2, reproduced from Grove (1996). He contrasts the “vertical” structure of the “old” computer industry to the “horizontal” structure of the “new”one. The vertical structure means vertically integrated suppliers, with IBM’s mainframe business as the reigning example. The horizontal structure is characterized by specialized firms; the PC business is the example.

Grove argues that the horizontal structure is more competitive. He is hardly alone in this observation. Almost all market participants characterize the “Silicon Valley” style of industrial organization as more competitive than the “IBM” style. The argument is simple, related to customer choice. Under the vertically integrated structure customers get only one choice, that of a full-service, all-products vendor. Under the vertically disintegrated (“horizontal”) one, customers may mix and match from a wide variety of vendors. Each horizontally layer -- chips, computers, operating system, etc. -- then has its own competition. The competitive race goes to the swift; under the horizontal structure, it goes separately to the hardware-swift, the software-swift, and so on.

The puzzle arises when you look at Figure 2 with an industrial organization economist’s eyes, especially with an antitrust economist’s eyes. Several of those “competitive” horizontal layers have very concentrated structures, typically suggesting a dominant-firm and fringe model. The Figure treats the PC business, so the dominant OS firm, MS, leaps to the eye, as does the dominant microprocessor firm, Intel. To be sure, there are some competitively-structured horizontal layers, such as computers (“boxes”) themselves. Yet an elementary structural analysis shows a puzzle. How can this be so competitive? To personalize the puzzle, Grove is the CEO of Intel, a company with a dominant firm market share in one layer of Figure 2. What in the world is the Figure doing in a book named Only the Paranoid Survive?

I am going to make the puzzle even more difficult by pointing out the other striking fact about structure: some of the dominant positions in Figure 2 are long-lived. Both Microsoft and Intel have been the largest microprocessor and microcomputer OS vendor, respectively, for over a

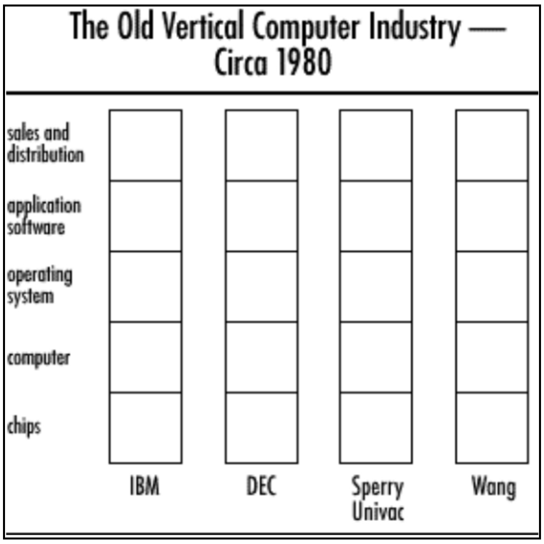

Figure 1.

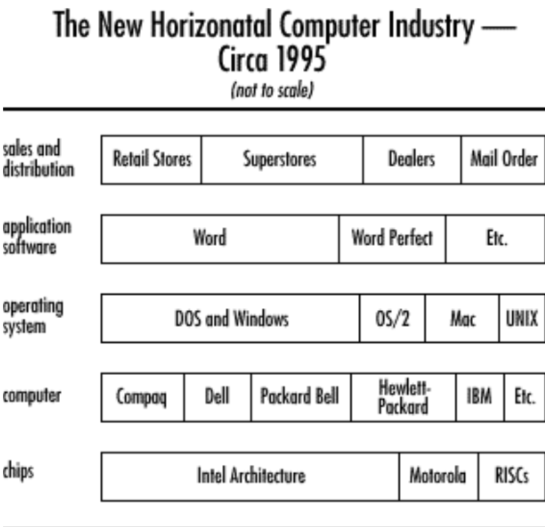

Figure 2.

decade – aeons in the PC business. The rest of this section attempts to resolve this puzzle. I will conclude that Grove is quite correct about the conditions of competition in his industry, as are the hundreds and hundreds of industry observers and participants who agree with him. I will also conclude that resolving the puzzle is the key to understanding computer industry competition, the first step in any antitrust analysis.[1]

2.1 Origins of Highly Concentrated Structure in Layers

The first part of the puzzle is resolving how competitive conduct could lead to the highly concentrated structures we see in many layers of Figure 2. Further, how can it lead to persistent dominant firms in some horizontal layers? There are three broad classes of explanations for concentration: strategic entry barriers, increasing returns to scale, and asymmetry of firms' costs (or other competitive capabilities.) The three classes are not mutually exclusive, so here, as usual in this kind of analysis, part of the problem is telling theories with very similar implications apart.

2.2 Platforms and Network Effects

Since the invention of the IBM System/360 in the mid-1960s, interactions between computer buyers and sellers have been organized around computer platforms, such as the System/360, Vax, Wintel, and Macintosh. A computer platform is conceptually simple, though modern platforms are extremely complex objects. A platform is a shared, stable set of hardware, software, and networking technologies on which users build and run computer applications. Platforms have interchangeable components, so many buyers can share the benefits of the same technical advance. This introduces network effects into the economics of computer platforms. Interchangeable components also permit individual users to stick the same platform over time, avoiding losses on long-lived software or training investments. When a platform advances in this way, it is said to have backward compatibility. Backward compatibility means that some of users' sunk costs – the costs of writing software, training people, etc., associated with a business information system – act to lock them in to a particular platform. On the other side, the costs of advancing a platform in a backward-compatible way can weigh heavily on the sellers of a mature platform. A large body of theory has emerged to explain industry structure concentration and persistence under de facto standards, like those at the heart

[1] I draw heavily on my work with Shane Greenstein (1997) and Franco Malerba (1997).

of computer platforms. A central idea of this theory is positive feedback among the different components associated with a platform.2

Powerful forces limit the number of platforms that compete for use in any particular segment of the computer industry.3 The very idea of a platform is associated with re-use across multiple sites, an inherent scale economy. Investments by the buyers and sellers in a platform are characterized by positive feedback. As sellers make the platform's various components better, the platform gets more attractive over time. As buyers use the platform more, they make the market larger, increasing the return to seller investment. As buyers use the platform more, they will discover new uses of it, creating an information asset that can guide the future direction of seller technical change. These virtuous cycles are associated with social scale economies, which means that there will be few platforms for any given segment.

Yet the same forces also offer excellent opportunities for the sellers of a platform to erect barriers to entry. With buyers locked in to a platform, a seller whose proprietary technology is embodied in a key platform component is in a powerful position to prevent competitors from having success. For example, customers might need to move in a coordinated way to a platform replacement. That is difficult, and the incumbent seller of a platform may well be able to prevent it, extending a monopoly. Further, critics hold that much of the monopoly in a platform may be due to luck rather than skill; the monopolist may be simply the firm in the right place at the right time. It is very difficult to tell the efficiency theory of concentrated structure from the barriers to entry theory. Exactly the same forces which provide the entry barriers are at the center of the efficiency theory.

The same powerful forces tend to make platforms persist for a long time. This, too, is a fundamentally ambiguous and difficult to evaluate fact. A platform is a device for coordinating disparate rapidly moving technologies and for market coordination between buyers and sellers. Both buyers and sellers make long-lived platform-specific investments. The long-lived investments associated with a platform lead to platform persistence. With some help from sellers with a proprietary interest in stretching out the life of a platform, platform persistence can easily go on inefficiently long. It is very

[2] This is also known as the theory of interface standards. See Besen and Saloner (1989), David and Greenstein (1990), David and Steinmueller (1994) and Besen and Farrell (1994) for more careful and complete statements. See also Katz and Shapiro(1998) in this volume, and the economics of networks web site at http://raven.stern.nyu.edu/networks/.

[3] By "segment" I mean no more than a group of customers with broadly similar needs and demands. It is one of the many words in this paper which is <u>not</u> used with antitrust market definition in mind.

difficult to tell whether this is for cost-minimizing, coordination-failure, or strategic reasons.

The theory of standards persistence has implications for the origins and demise of platforms. Virtuous cycles are easy to maintain but hard to start and hard to stop. Accordingly, platform standards are hard to stop, hard to start, and easy to maintain. A platform needs a critical mass of adopters and a critical mass of complementary software (and sometimes other components). Positive feedback underlies survival of existing standards and getting over a hump of acceptance for new standards. If a new standard does get over the hump then positive feedback quickly favors it. Getting over that hump, however, may not necessarily come easily or quickly. The implications for the dynamics of computer industry structure are that platform switches – movements of large numbers of users from one platform to an incompatible or only partially compatible one – will be rare. Typically, it takes a substantial new technological opportunity to get the new virtuous cycle going. 4

This last point has strong implications for the dynamics of industry structure. We should expect punctuated equilibrium. There will be long eras of stable buyer-seller relationships. During these eras, technical progress will make existing platforms better, and deepen existing relationship between sellers of platform components and platform users. These eras of stability will occasionally be punctuated by epochs of radical change. In an epoch, platforms can be replaced, key platform components can be replaced, and dominant firms can be replaced. It is neither desirable nor even possible to have frequent epochs; the costs of all that change are considerable.

When will epochs occur? When will they involve significant competition? The most important conditions are these. 5 First, there must be quantum improvement in technology, radical technical change. Incorporating a quantum improvement into an existing platform can be quite difficult - think of incorporating 16-bit microprocessors into CP/M or the internet into Windows. Incorporating the steady stream of incremental technical improvements into existing platforms has proved not very challenging. Incorporating radical ones can take time and thought. Radical

[4] For analysis of both the rarity of platform shifts and the value of a step-up in technological opportunity in getting a new platform's virtuous cycle going, see Bresnahan and Greenstein (1997). In particular, Section IV has analysis of the technical conditions that permitted the platform shift to the IBM PC from CP/M in the microcomputer world and the platform shift in large company computing from IBM mainframes to client/server architectures in the enterprise-computing world.

[5] See Bresnahan and Greenstein (1997), especially section IV, for a full statement of this argument and for analysis of the important epochal platform shifts in computing.

technical change thus leads to a transitory weakening of the existing platform's positive feedback.

Anatomy of Competition in Epochs

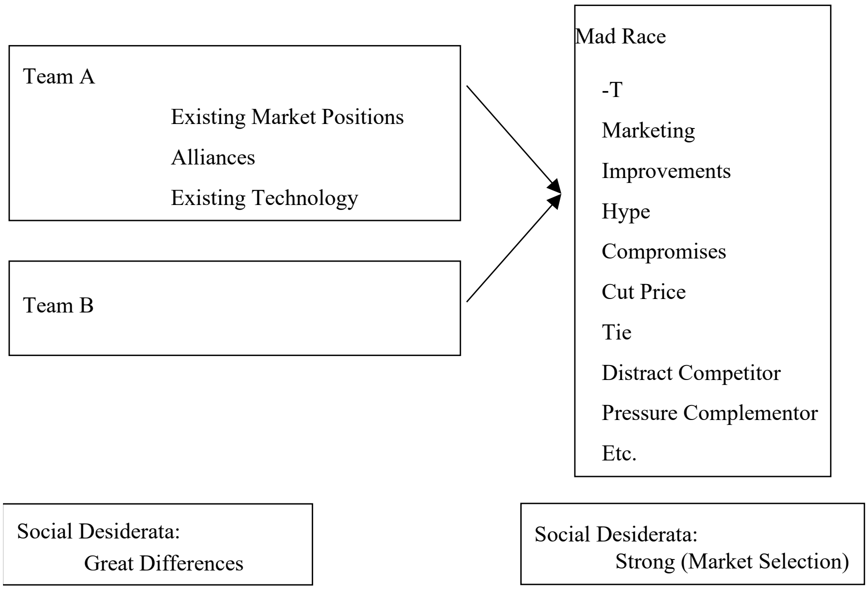

Figure 3.

The second precondition is related to the nature of competition in epochs, which has strong racing elements. (Cf. Figure 3) This is to the disadvantage of completely de novo entrants. Since starting a new virtuous cycle of positive feedback involves large investments in many types of technical progress and the effective coordination of sellers' and buyers' efforts, epochal change calls for an entrant with a variety of resources. Technical clout is important. A new platform needs to have some technologies already in place and to have the capabilities to advance other technologies. Marketing and management clout is important, too. Virtuous cycles work best when all participants are convinced they are going to work well. So an entrant with marketing connections to users and with the credibility to encourage complementors will have a better chance. If the entrant platform lacks these assets, the incumbent can force, and win, a technology race during the epoch. Finally, the incumbent platform's rents are at risk in an epoch. Incumbent sellers' incentives are to win the epochal race at any costs up to the total of their rents. Entrants with clouded or confused incentives will be at a marked strategic disadvantage. Even the best entrant will be at some strategic disadvantage. Platform persistence is the norm in computing, whether for efficiency reasons or strategic ones. Bet on the incumbent if you can get even money.

2.3 Best firm might be the one we see winning

The possibility that firms may vary in their costs (or other competitive capabilities) offers yet another theory of concentrated industry structure.6 Firms could be dominant in the various layers of Figure 2 because they are the best at carrying out the function of that layer. (This is very much the theory advanced by Grove (1996), much of which is concerned with the organization and leadership of a computer industry firm with the goal of being the best in a layer.) The dominant firms earn rents on their superior abilities – be those technical, in marketing, or in management.

These explanations interact in epochal competition. Users trade off the advantages of the relationships they have built up with existing platforms and existing suppliers against the new technology and possibly better supply of the new suppliers. Thus, famously, IBM was better at building a platform than other firms in the 1960s, Microsoft better understood the new computer industry structure of the PC business in the 1980s, and the Silicon Valley organization for client-server architectures better fit the 1990s than the IBM organization.[7]

2.4 These Theories in the Old and the New Computer Industry

The obvious application of the network / platform theory is to Figure 1, and to IBM's longtime dominant position in the commercial computing business. IBM mainframes, including hardware, software, and networking, defined the platform. Commercial computing tipped to the IBM platform, as users in large data centers made platform-specific investments. The era of IBM dominance was decades long, and the epoch ending it has proved wrenching for IBM's old customers as well as for the dominant firm itself. No one knows whether it was the social scale economies of the IBM

[6] Demsetz (reprinted in 1989) brought this argument forward as part of an efficiency explanation of concentrated structures with high profits.

[7] See, to get a small taste of a large literature, Chandler (1997) on IBM and the Silicon Valley form, Baldwin and Clark (1997) on the new form, and Steffens (1994) and Ferguson and Morris on the PC "new game".

platform, anticompetitive lock-in, or the superiority of IBM's management which let the era be so long.8

The same theory applies to the more vertically disintegrated structure of the new computer industry in Figure 2. But it applies in a somewhat different way. First, it applies essentially without alteration to explain why there are few platforms in the "new" computer business. The cost and strategic forces that lead to there being only a few platforms serving any portion of commercial computing are still in force, and they tend to play out strongly in the present as they did in the past, leading for example to a dominant personal computer platform (PC) and a substantially weaker second (Mac.)

There is something new in the vertically disintegrated structure. First, my theory of the concentrated layers in Figure 2 is that each of them is associated with a local and specific version of the network-effects / positive-feedback theory. The same forces that used to play out in the overall computer industry in the IBM era now link a subset of the firms in the vertically disintegrated structure.

1. Intel's microprocessor architecture embodies a standard that is used in a wide variety of brands of computer. Intel gains from the innovative efforts of those computer manufacturers, now typically in such areas as distribution and support, though earlier in fundamental advances in the design of the computer. The positive feedback cycle contains at least Intel and its immediate customers, the computer makers. Intel's microprocessor architecture provides a platform over which the seller has considerable control. Users and computer companies are fairly well locked in to the Intel standard. Licensed clones of Intel microprocessors played a large role in the early part of the era. Currently, there are unlicensed but (at least partly) compatible competitors.
2. Microsoft has had a dominant position in the operating system layer for some years. Here, as above, the network effects work to make a single firm's proprietary technology very important at the center of a network of jointly invested platform components, mutually reinforced by positive feedback.

[8] Different authors took contrasting sides of the *U.S. vs. IBM* antitrust case, seeing IBM either as a brilliant industry creator or as a defender of monopoly. They see IBM's invention of the platform either as valuable use of scale and scope economies or as barriers to entry, and see IBM's customers either as well supported or as locked in. For contrasting analysis and characterizations see, e.g., Brock (1974), Fisher et. al. (1983), and DeLamater (1986). I am not sure that anyone who tends to like antitrust intervention generally has been convinced by the right wing in this debate, nor that anyone who tends to dislike it generally has been convinced by the left.

This tendency to vertical disintegration and to highly concentrated structure in many layers is not limited to the PC. It has been recreated, on a larger scale, in the new computer industry based on networking together many computers. Cf Figure 6, below.

We are now half there in terms of the positive analysis. We understand why there are dominant positions in several horizontal layers of Figure 1. We understand why those positions tend to be long lived, and why it takes a substantial improvement in technology to end an era with a new epoch. If anything, we have too many theories of these phenomena.

It has proven extremely difficult, even in retrospect, to tell these various theories of concentrated structure apart. We are now having a debate over which of these predict-alike theories best explains Microsoft's position. I anticipate that it will be just as difficult to resolve those questions as it was in the case of the long debate over IBM's dominant position.

There is a good reason for this. The various theories of concentrated structure interact in a way that makes it extremely difficult to separate them. Let me take just one example. Some see platforms as lock-in devices, and point to the importance of history in locking in users, talking of "small historical accidents." Exactly the same argument is claimed by the other side, when they say that those specific firms that foresaw the direction of development of markets the earliest emerged as the ultimate leaders. The problem for policy analysis is that there are likely to be elements of truth to both sides. What if Microsoft is, as IBM was, controller of a standard that locks in customers through its social scale economies because that particular firm saw the logic of the computer business in its era the earliest?

These competing theories of concentrated structure also leave a key fact unexplained. Why do so many participants report the structure in Figure 2 as competitive? Understanding this calls for significant new analysis, to which we now turn.

2.5 Divided Technical Leadership and Vertical Competition

To explain the reported high degree of competitiveness in Figure 2, I introduce a new market structure concept, divided technical leadership, i.e., the supply of key platform components by multiple firms.9 Under divided technical leadership, there is no single vertically integrated firm with control over direction of a platform. Instead, a number of firms supply, in the short

9 The concept comes from my work with Shane Greenstein; see our 1992 paper.

run, and invent, in the long run, platform components. Frequently, different firms will have positions of dominance in different layers. These firms must cooperate in the short run to serve their customers. They find themselves, however, in competition when it comes to invention. This combination of the need to cooperate and to compete was first labeled "co-opetition" by Ray Noorda, of Novell.10

Divided technical leadership contains the seeds of competition for control of a platform. The reasons are technical, marketing, and strategic. Technically, there are no given and exogenous boundaries between the layers. The functions now performed by one platform component might instead be performed by another. Both software and hardware have shown this malleability. The firms supplying key components of the same platform often have broadly similar technical capabilities. Each would be capable of taking over the other's position. From a marketing perspective, each key component seller in a platform has connections to the relevant customers. Thus, divided technical leadership is a situation in which firms with broadly similar technical and marketing capabilities co-exist in close proximity. This gives the relationship between dominant firms in the distinct layers its competitive elements alongside its cooperative ones.

Strategically, there are a variety of reasons for divided technical leadership to break out into open competition for control of a platform. Firms share common customers, who buy products from both to integrate together, a strong impetus to cooperation. Yet high prices in one layer rebound to the disadvantage of sellers in other layers.11 So, too, does slow technical progress in one layer. So, too, does failure to cooperate in making products work together, Accordingly, a firm in one layer has an incentive to end greedy pricing, technical sloth, or standard-setting misbehavior in another layer. Similarly, a firm in one layer has every incentive to attempt to grab the rents of a firm in another layer. Any firm may do this by winning a technical race. A dominant firm may also do it by leveraging its monopoly.

An important limitation on the extent of competition between firms under divided technical leadership is the typical industry structure in each component layer. Under divided technical leadership, there are often several distinct network/effect positive feedback logics in the same platform. For example, we now see an Intel network and a Windows network within the Wintel platform. There used to be a separate WordPerfect network in that

[10] It has recently been given a careful and general treatment by Brandenburger and Nalebuff (1996).

[11] This is the familiar "iterated monopoly" problem.

same platform, and before that there was an IBM PC network.12 The basic laws of network effects are still in place with regard to each separate network in a platform. Each separate network has its own positive feedback, and so tends to have a persistent dominant firm during an era.

While the dominant firm at the center of each network tends to persist, divided technical leadership offers two kinds of competition. (1) Within an era, there are constant border wars at the boundaries between layers. (2) The other suppliers in a platform provide a stock of ready and able entrants to trigger epochal competition. Divided technical leadership doesn't mean that it is easy to enter the market of a persistent dominant firm. But it does come with "built-in" potential entrants who have marketing and technical clout. These two forms of vertical competition from leaders in nearby layers constrain the market power of a dominant firm in any particular layer. The tactics and strategies of vertical competition are important for our present purposes, because they are the key mechanisms by which future computer industry structure will be determined and because they are the mode of competition that antitrust policy should seek to protect. Vertical competition takes on a day-to-day form within eras and a much more radical form during epochs. I examine these two forms in turn.

Within eras, divided technical leadership means that different firms are constantly advancing different parts of computer technology. This has Schumpeterian advantages. It means that the inventive abilities of a number of different firms come into play. These firms have different ideas and inspirations. They also have different incentives. Under divided technical leadership, then, there are both more sources of invention and fewer bottlenecks to bringing inventions to the market. Finally, the constant change and invention opens up a variety of strategies for co-opetition within eras. Strategies deployed by firms in one layer against firms in another layer include:

1. Dominant firms in one layer routinely attempt to advance their own technology in a way which has implications for the interface with adjacent layers. Interface standards races are struggles for control and can be highly competitive.
2. Since the boundaries of software markets are highly malleable, a dominant firm in one layer may attempt to include some or all of the complementor's products' functions in its own.

[12] As these examples suggest, divided technical leadership was first important in computing in PCs. It is now quite important in computing generally.

3. Attempts to render the other firm's product less of a bottleneck. A dominant firm might try to have its technology work with all the complementors in another layer, tending to make them more of a commodity. Or, rather than simply bargaining over rents with one complementor, a firm might attempt to strengthen the second or third-place complementor.
4. As new technological opportunities arise, each dominant firm in each layer can be expected to extend its dominance to new areas. Existing interface standards often embody an uneasy truce among the co-opetitors. The opportunity to extend standards contains strong competitive incentives for proprietary extensions. These often take the form of technology races.
5. Jawboning. Microsoft, then a leading supplier of Macintosh applications, famously asked Apple to cut prices on Macs and open the hardware architecture. Had Apple said yes, that company would now enjoy a client OS monopoly much like the one Microsoft ultimately came to enjoy itself. But Apple said no, and marched resolutely towards its current marketplace irrelevance. Such is the efficacy of jawboning.

It is possible that the accumulation of such day-to-day vertical competition moves control of a standard without a change in standard. Thus a series of day-to-day vertically competitive activities moved the PC business from the IBM PC to Wintel. The advantage of such a shift is very considerable. Users do not need to switch platforms, and the value of users' investments in the existing platform is preserved.

Sometimes, however, vertical competition that shifts control is epochal for buyers as well as sellers. Buyers give up their investment in an existing technology, and switch to a new one. Dominant firms in nearby layers provide the entrants for the next epoch. For example, Microsoft was the entrant into word processing and spreadsheets on the PC platform, then dominated by other firms. Existing WordPerfect and Lotus customers had to bear switching costs. When this kind of epochal vertical competition occurs, it typically leads to huge lost rents for the incumbent dominant firm. The mere threat of epochal vertical competition is a powerful incentive to incumbents to serve their customers better. It is also a powerful incentive to better lock their customers into persistent monopoly. When epochal vertical competition comes, the incumbent wants to be in a position to react to competition strongly and quickly.

It is not easy to spring customers loose from the network effects of the incumbent's standard, not even for an entrant from an adjacent layer. The most common trigger for an outbreak of epochal vertical competition is a major technological dislocation. An unpredictable change in the technological basis of computing can catch incumbents off guard. If the new developments are not quickly integrated into the incumbent's products and strategies, customers – even heretofore locked in ones – may well switch. This, then, is the basis of "only the paranoid survive." The competitive threat to a dominant firm comes from firms that have been complementors, not competitors, in the past. The competitive threat comes from an unpredictable direction and at an unpredictable time.

While it may well be right for incumbents to worry about epochal vertical competition – and it is certainly right for incumbents who are not Microsoft, Cisco, or Intel to worry about it – the attacker's prospects in epochal vertical competition are usually not all that bright. Incumbents tend to react aggressively to attempts to end their position of dominance. Incumbents benefitting from existing network effects tend to have strong positions. Society and the potential entrant / attacker both prefer the same conditions for epochal vertical competition, but for different reasons. The entrant's odds are best when there is a major technological dislocation. The odds are best when the entrant offers a technology or a market structure that are radically different from the existing incumbent offering. (Cf. the bottom of Figure 3 for analysis of social desiderata.) The radical difference gives users a very distinct choice, which they will need if they are to walk away from existing platform-specific investments.

2.6 Epochal Vertical Competition in the PC Business and its Structure

In its earliest stages, the PC business was even more vertically disintegrated than Figure 2 shows it is now. An important event was the introduction of the IBM PC. There was something of a race to establish a new standard platform for personal computing in the 16-bit era. There was an incumbent technology, though the transition from 8- to 16-bit technology was disruptive enough that the positive feedback of that technology was weakened. IBM, sponsor of what became the leading new platform, chose to pursue speed by using a wide variety of available technologies from other firms. These included many different hardware and software components, including but not limited to microprocessors from Intel and operating system from Microsoft. This appears to be a systematic feature of the new computer industry: the desire for speed makes firms cooperate with outside sources of technology.

In a story that has been told many times, a complex series of interactive moves between Intel, Microsoft, IBM, and the other manufacturers of PC "clones"caused a shift in the control of the PC standard from initial sponsor

IBM to "Wintel."[13] See Figure 3. A key opportunity for non-IBM vendors arose when the Intel 80386 microprocessor was introduced. When Compaq beat IBM to the punch in designing a PC with an 80386 at its heart, there began to be an "industry standard architecture" where there had been the "IBM PC" before. There was considerable confusion about how much different a 386-based computer would be than a 286-based one; they turned out to be very similar, which played to Compaq's advantage. Vertical competition between Intel and IBM was part of this: it was helpful to vertical competitor Intel that there were clone manufacturers to serve as potential allies against IBM. Operating system vendor Microsoft got into the game as well, taking advantage of the weakened standard-setting position of IBM to make the operating system more and more the definition of what the computer was. There was considerable confusion about the role of a graphical user interface, and eventually Microsoft's Windows triumphed over the IBM OS/2 initiative. (IBM advocates also argue that Microsoft's strategy in developing both a joint OS with IBM and a go-it-alone OS was duplicitous. IBM in any case lost the standard-setting race) Operating system vendor Microsoft also found that an "industry standard architecture" was not much of a competitor against a concerted and unified vertical competitor.

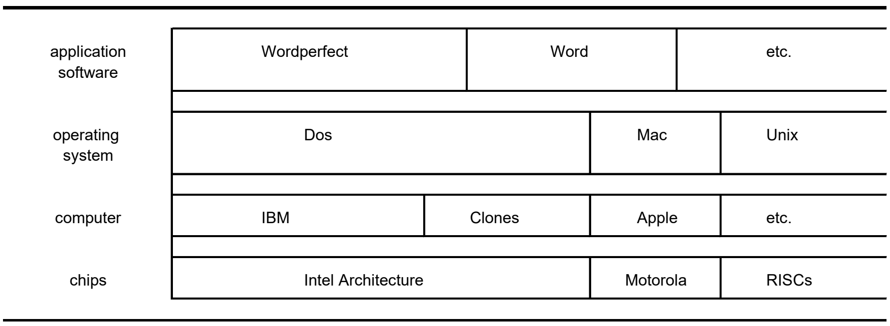

Figure 4.

There are several lessons here. Far and away the most important is that competition came from within the industry, from another horizontal layer.

[13] For detailed discussion from business and economics perspectives, see Ferguson and Morris (1993), Steffens (1994), and Bresnahan and Greenstein (1997).

Structurally, the existence of a second-place firm like the clones in a particular layer makes vertical competition easier. An open standard in one layer is particularly vulnerable to competition from the next layer over. Speed matters. Confusion helps entrants. In the conditions where the entrant might win, it is very difficult to foresee either the beginning or the evolution of an epoch.

1. WordPerfect had, for many years, a dominant position in word processing for users of the IBM PC. In this instance, the platform is the word processing program itself, and the positive feedback comes from typists' investment in program-specific knowledge, in employers' definition of jobs around a single program, in the creation of training materials, of files stored in program-specific formats, of examples and "templates" and "macros" that worked only with the platform-program, etc. The network effect added up to a very considerable lock-in to the WordPerfect standard, to the considerable advantage of the seller of the program. This was by far the largest use of PCs, and the network effects / platform equilibrium gave WordPerfect corp. a correspondingly large monopoly.
2. In the second-largest applications category, a comparable position was held by the Lotus 1-2-3 spreadsheet program. The same forces worked to build positive feedback in a network around a standard held proprietary by Lotus Development Corp. (One might put rather more emphasis on macros and templates in the spreadsheet network than in the word processing network, and on formal intellectual property protection, as there were a series of lawsuits between Lotus and imitators.)
3. The WordPerfect standard was later replaced by the Microsoft Word standard. The Lotus 1-2-3 standard was later replaced by the Microsoft Excel standard. The opportunity for one seller to replace another's standard was associated with a step-up in technology, the introduction of the Windows operating system, the integration of a graphical user interface into the OS, etc.[14] It was also associated with a spectacular error on the loser's part, an attempt to have WordPerfect run on many different operating systems, effectively turning them into commodities. It was associated with a substantial change in the way applications work, leaving much more integrated "suites" where products had been mostly stand-alone. It was associated with claims of foul play against the winner. It is in any case over, and MS now enjoys the same kind of

[14] See Breuhan (1997) for a study of word processing lock-in and of the epoch that ended the WordPerfect era.

positive feedback / network effects in its Office suite, as the standalone wordprocessor and spreadsheet firm used to.

2.7 Vertical Competition and Welfare

The vertical competition arising from divided technical leadership has both socially desirable and undesirable elements. The desirable elements can be seen in my explanation of how Grove was right. The vertically disintegrated structure of Figure 2 is different from the vertically integrated structure of Figure 1. The “new” computer industry is more competitive than the “old”. There are two reasons. First, there are more competent entrants available to attack any particular dominant firm’s position. Second, entry is easier because there are so many different sources of technological shocks that might end an era. Furthermore, the ability to quickly recruit neutral complementors helps an entrant get going quickly. (Cf. Figure 3)

On the other hand, the same structure is a fertile breeding ground for anticompetitive acts. Suppose dominant firm in layer A has an incentive to end greedy pricing, technical sloth, or standard-setting misbehavior by dominant firm in layer B. Then, of course, dominant firm B has every incentive to remove dominant firm A before any of that happens. Thus, epochal vertical competition might break out as an attempt to consolidate B’s position. If dominant firm B is in the business of watching out for threats to its rents and preventing them, this is one of the strategies it might try (along with things which are better for society, like deepening its relationships with existing customers, making its products cheaper and more powerful, etc.). B protects and extends its own monopoly by both legal and illegal mechanisms. As in any other situation in which competition tends to lead to consolidation of industry structure, epochal vertical competition can lead to either better or worse outcomes.

Vertical competition is the basic working reality of competition in the computer industry. Antitrust authorities have tended to view such vertical competition as attempts to extend monopoly power. Unfortunately for antitrust policy formation, however, exactly the same action which is an attempt to extend monopoly power is also an attempt at competition, as I showed above. To make life even more difficult for those of us attempting to analyze vertical competition, its epochal form has a certain “once and for all” flavor. The struggle between firms in distinct layers that is epochal vertical competition frequently leads to vertical consolidation, with one of the firms finishing with a far weaker position technically or exiting. That, ultimately, is why industry participants believe that they have to be paranoid. And that is also one reason that antitrust enforcement is a very tricky business. Miss the window and valuable competitors might be gone forever.

The vertically disintegrated structure of Figure 2 is different from the vertically integrated structure of Figure 1. The "new" computer industry is much more competitive than the "old." The explanation has two parts. First, for any particular layer in Figure 2, the arrival rate of potential epochal competitive incidents is far higher. This is because of the increased supply of entrants, the dominant firms in the other layers. Not a fancy theory, this story of potential entrants is rooted in the hard reality that firms in the different layers talk and act as if they are in competition with one another.

3. THE GRAND DYNAMIC OF COMPUTER INDUSTRY COMPETITION.

Horizontal competition tends, in crucial layers, to lead to dominant firm structures. Some other layers are less concentrated, but also less influential on the development of the industry. Vertical competition in its most radical, epochal, form is a one-shot deal. Either the incumbent or the attacker is removed as a strategic force in the industry. Thus, vertical competition tends to lead to vertical consolidation. The race during a vertically competitive epoch will be very productive for society, but the ensuing era will typically be more concentrated vertically. The forces I have been writing about so far are ones that tend ultimately to lead to a concentrated structure, both vertically and horizontally. There might appear to be an entropy law in which competitors are steadily removed.

Fortunately, there are powerful offsetting forces. These routinely disrupt the convergence to a concentrated structure. The backbone of the offsetting forces is expanding technological opportunity. We have already seen how it erodes dominant positions in the industry. It also creates new layers within commercial computing, restarting the process of divided technical leadership and vertical competition.

We have, therefore, the grand dynamic of Figure 5, On the left, the highly productive but unfortunately entropy-laden process of convergence given existing technologies. On the right, we have the processes that constantly renew competition by injecting new layers. Often coming through technical computing, whole new applications areas or application to new devices, these new layers create new power bases for vertical completion. The entropy process is routinely disturbed by the injection of new energy.

3.1 The Grand Dynamic is Systematic

The right hand side of Figure 5 is based on two distinct kinds of technological advance. Raw computing power and network bandwidth keep getting cheaper, for fundamental technical reasons. Those advances permit new uses for computers, making it economic to digitize ever less-digital things. They permit linking existing devices together more and more, by making it economic to link together ever more distant or less valuable data.

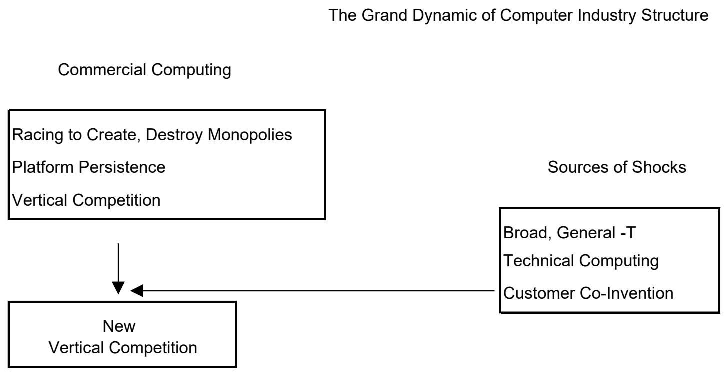

Figure 5.

Over and over again, these expansions in technological opportunity permit expansion of the computer industry. While commercial computing, and its dominant firms, value backward compatibility, many of these new areas care only about raw processing power or bandwidth. As a result, new platforms regularly grow up in technical computing. It is rarely cost effective for an incumbent dominant firm to attempt to compete them out of existence. After a period of development, the technical computing platforms migrate toward competition with locked in commercial computing platforms.

Another direction of this dynamic is to ever-smaller devices. Again and again, these have first been sold to technically sophisticated users. Only later have they migrated to commercial computing, where they have injected new competitive layers.[15] Another dimension of this dynamic is the use of networking to bring previously unconnected technologies into vertical competition. This is what the internet did. The dominant firms from both client and server side today find themselves in rabid vertical competition. Technical change brought them to this position.

[15] See Bresnahan and Greenstein (1997) for a history of indirect entry efforts.

The creation of new vertical structures by assembling together existing bits and pieces of computing leaves gaps in the computer industry. So new vertical layers are invented to take advantage of this technological opportunity. Coincidentally, they take advantage of weaknesses in the technology or customer service of existing dominant firms. In one era, the database management system played this role. It made developing applications far easier, and turned out not to be dominated by IBM. In the present, enterprise software may well play this role. While the provision of tools and other software (OS, DBMS) for applications development may be dominated, it is very hard to see how a dominant firm in those technologies would be either capable or willing to take over SAP and Peoplesoft's business. The creation of new layers is ever an entry opportunity.

Networked computing, in which those PCs are relabeled "clients" and connected to powerful "servers", is awash in divided technical leadership. In Figure 6, I sketch some of the layers that one would need to think about in networked computing. Like Grove's Figure, this is designed to lay out some of the most important structural features rather than offer a complete inventory of technologies.

Selected Horizontal Layers in Networked Computing
[not to scale]

Client Applications	MS Office
Client OS	Windows
Browser	IE, Navigator
Client System	Dell, IBM, Compaq
Client Microprocessor	Intel
Distributed Technologies	DCOM, Corba, JAVA-RMI
Distribution & Fulfillment	Dell, Compaq
Network Access	AOL, ISPs, MSN
Internetworking OS	CISCO
LAN OS	Novell, Windows NT
Server OS	UNIX, 3090, Windows NT
Server DBMS	Oracle 8, DB2, MS SQL-Server
Server System	HP, SUN, IBM, Windows NT
Groupware	Notes, Many
Custom Software	EDS, Perot Systems, Andersen
Enterprise Systems	SAP, Baan, Peoplesoft
Service & Support	IBM (ISSC), Compaq, HP

Figure 6.

The creation of networked computing as an important competitive force has gone through several phases. Throughout the 1970s and 1980s, there were distinct networking architectures for distinct purposes. IBM had a very successful proprietary networking architecture for commercial uses, for one example, and we have already discussed the internet for another. At the end of the 1980s and getting into the beginning of the 1990s, a vertically disintegrated "client/server" industry grew up to challenge IBM in commercial computing for large, networked applications. This was a magpie technology, with clients drawn from the PC world, servers from the workstation or minicomputer world, software from both. Networking advances such as local area networks provided some technologies, and other technologies were developed anew. The technology was a magpie because that was the way a reasonable competitive alternative could be assembled quickly.

Round 2 made another magpie technology with the help of the internet. It took fundamental networking technologies, such as TCP/IP, the WWW, browsers, etc. from the internet itself. It drew on a wide variety of client and server technologies to make a new networked platform for electronic commerce, for advertising, for intranets and extranets. It has been extraordinarily successful, and has offered a wide variety of entry opportunities. It has permitted new attacks on dominant firm positions in both clients and servers. (I take up detailed analysis of a few of these in a moment.)

The dynamic means *Dauer im Wechsel*. The computer industry remains, as it has been for decades, a mix of large firms with dominant positions in the currently most valuable technologies, and smaller more entrepreneurial firms opening up new areas. The balance between the two arises only because of the ongoing injections of new opportunity on the right-hand-side of Figure 5. Has this dynamic ended? Are we nearing the end of this round of new injections of entrepreneurial energy? Will there be a final convergence to an industry dominated by one firm, such as Microsoft? I think not. The striking thing about the computer industry is how, at age fifty, it still has surprises. Many people, far more fluent technologists than I, say that we have seen the last big breakthrough. Can I name the next internet, the next big shock to cosy entropy and convergence?[16] No, but that's part of the point. I couldn't have the named the last one either. And neither could the people who now predict that the final convergence is upon us. What we have to remember is that, the last time that it appeared that the final convergence was upon us, a key technology was growing up and getting ready to strike down incumbent dominant positions. And where and why was this technology being developed? The WWW, to let Professors of Physics share working papers! It is a very important part of the competitive renewal process on the right hand side of Figure 5 that it not be obvious where the next important technology is going to come from.

[16] It might very well come from the extension of computer interface standards to devices that are not now computers – televisions, telephones, etc. Cf. Flamm (1998) in this volume.

3.2 The Grand Dynamic and the Microsoft Cases

The left hand side of Figure 5, showing convergence to very concentrated structures, might provide the beginnings of a reasoned explanation of the USDOJ's intervention in the computer business. Vertical competition has tended, lately, to have MS as the winner. This is especially true of epochal instances of vertical competition. We see the same firm, more and more, as the dominant firm in a number of vertical layers. Since the computer industry is vertically competitive because it is vertically disintegrated, this vertical consolidation is creating a less competitive structure. Long-run technological competition will be reduced, and with a dominant firm in each layer we can expect little competition in price – especially if most of those dominant firms are the same one.

This is not at all a trivial observation. If it were correct, we would now be at the end of the interregnum between an IBM monopoly and a Microsoft monopoly. The span of the new Microsoft monopoly might come to be about as broad as the old IBM one, covering almost all of commercial computing. Grove's "new" computer industry with its Silicon Valley organizational form would be relabeled as the "interim" computer industry, and competition would be replaced by peace. The Antitrust Division would look on the new pax Redmondiana with the same dislike it had for the old pax Armonkiana.

While that argument is serious, it is incomplete. It fails to be complete for each of the two Microsoft cases in two very distinct ways. Both are related to the grand dynamic.

The pax Redmondiana story, if applied to the narrowly construed PC business, is a reasonable description of competitive circumstances at the time of Microsoft I.[17] Consolidation of the most important application software categories with the operating system left no software power base for vertical competition. Intel and Microsoft had distant enough capabilities that vertical competition between them, while ever present, never rose to the epochal level.

The problem with MS-I was one of policy effectiveness. The relevant epoch of vertical competition was over once Windows 3.x and the Office suite were established. We were in the era of MS dominance of the most important PC software. Eras are very hard to end, and attempting to reduce barriers to entry when there are no credible entrants is a losing proposition.

[17] Here I use MS I to denote the case originally brought by the FTC, then pursued by the DOJ to the 1994 consent decree.

What could a reasonable antitrust policy do once a combination of Microsoft rapaciousness, market forces, and suicidal tendencies on the part of ex-competitors had led to an established dominant firm position?[18]

While I have no inside information, I hope that it is this small prospect of policy effectiveness that led the Antitrust Division to settle for a weak MS consent decree in 1994.[19]

Clearly MS-II, the new antitrust case against Microsoft we all anticipate, is not subject to this problem. The current cluster of anti-Microsoft competitive initiatives are still viable. We are in epoch, not an era, so policy might be effective.

What has changed, of course, is the arrival of the internet. The era of MS dominance of the vertically integrated desktop could only end with a step up in technological opportunity. Such an opportunity came very quickly.

The internet was about twenty years old when it became an important technology (or cluster of technologies) for commercial computing. A wide variety of internet technologies, interface standards, and tools advanced. Technical computing -- military, engineering, the nerdier ends of universities -- can draw on exactly the same fundamental technological opportunities as commercial computing. So the internet matured, well out of competition with established commercial platforms.

The "out of competition" point in important. Many technologies have grown up in technical computing and then migrated to commercial computing. Think of the factory minicomputer, the hobbyist microcomputer, and the engineering workstation.[20] As long as these technologies are confined to technical computing, they are too various and distant to draw the competitive attention of commercial computing firms. A few technologists predict that they will be very important, but this is dismissed as techie softheadedness. Thus, no commercial computing dominant firm views them as an important threat, and none bothers to

[18] I must confess to having used somewhat more colorful language, in 1991, in asking what the government was going to do with Microsoft when they caught it. I compared MS to a firetruck and the FTC to a dog.

[19] An adviser to the Antitrust Division in MS-I told me that the decree was effective until MS began to flout it in the browser wars. He did not say what the supposed effects were. In what markets did the absence of MS anticompetitive practices make competition fairer, and what competitors successfully served what customers as a result?

[20] A fuller account of their migration to commercial computing can be found in Bresnahan and Greenstein (1997).

compete against them as long as they serve only technical computing segments. The right-hand side of Figure 5 exists because it is out of competition with existing dominant firms.

A change comes when technologies used to serve technical computing migrate to commercial computing. At this stage, they do come to the attention of existing commercial computing firms and can draw very aggressive competition. The potential threat to existing seller rents in the commercial computing segments becomes visible in the migration. This pattern of "indirect entry" means that potential entrants into commercial computing are not quite so vulnerable to competitive counterattack as they are typically painted. At the time of their migration they are not -- technologically -- infants in the crib, easy for dominant firm to strangle. They are immature in a customer connection and market sense (and a marketing capability sense) but not in a technical one.

4. CONTEMPORARY EXAMPLES OF VERTICAL COMPETITION

I now turn to several examples of vertical competition in the contemporary scene. These illuminate, from a variety of perspectives, the current epoch. I look at Microsoft's vertical competitive initiatives against server-side dominant firms, and then at two anti-Microsoft initiatives.

4.1 A Contemporary example: server-side DBMS

While MS is famous as the client-side dominant firm, in other areas they play the role of entrant rather than incumbent. Examining one of those areas helps us analytically in two ways. First, it helps us look at the general laws of epochal vertical competition. By looking at the reverse situation, we can split our assessment of MS the competitor from our assessment of the effectiveness of competitive processes. Second, it offers an opportunity to consider the likelihood of a complete takeover of the computer industry, including the internet, by MS. Of the very wide variety of server-side technologies where MS appears as the entrant, I will discuss only one, database management systems. This will serve to bring the analytical issues to the fore, though it only begins to scratch the surface of a competitive analysis of the server side.[21]

[21] A wide variety of technologies supplied by a wide variety of companies are used in constructing business computer systems. Microsoft's entry into this business has an operating system, Windows NT, and a suite of company-wide software applications at its core.

Industrial-strength database management systems are used in company-wide or divisional computing. Applications built with these systems are at the heart of doing business, managing business, and serving customers. (1) Doing business is more and more the task of transactions processing systems, which use DBMS and other complex pieces of software not only to record but also to control buying and selling. Once a great many transactions have been captured in a database, they are available for analysis. (2) A wide variety of analytical applications are increasingly at the heart of managing large complex organizations. Reports based on the information in DBMS are growing ever more complex, as such new technologies as OLAP, data warehousing, and data marts increase the managerial value of raw data. (3) Customer service can be enhanced with the use of DBMS-based systems, as when Fedex tells a customer where the package is, or a bank customer service representative, automatic teller machine, or web page tells a customer her current balance or the status of a check.

Since these system are business information systems at the heart of company operations and management, the customers for a DBMS are usually senior IT managers and/or senior business people in corporations. They will be planning to "design in" the DBMS and its complements into a complex system involving not only software but jobs and customer service. Accordingly, they demand a close working relations with technology vendors in terms of service, support, and technical information. Trust relationships about future technical developments can be very important, as many DBMS applications are critical to continued functioning of the business. DBMS transactions systems are "mission critical;" when the system goes down, business stops.

Very large changes in complementary and competitive technologies have affected the DBMS layer. The steady growth in networking has expanded opportunity for DBMS applications. The earliest growth of this was in the vertical world of Figure 1 (IBM mainframes connecting IBM DBMS over IBM networks to IBM terminals). More open systems have grown up, using UNIX servers with DBMS systems from such vendors as Oracle. Growth in mixed networks -- first called client/server, now often using internet technologies – have been a powerful force in DBMS demand. This has meant new opportunities for vertical competition between client-side software firms and server-side firms. Finally, the introduction of business information systems from firms such as SAP, Baan, and Peoplesoft has meant new competition for DBMS as well. Rather the using DBMS and related tools to build a unique system, large companies might obtain a more nearly turnkey system.

These software products are deeply embedded in business information systems in companies. They are closely linked to a large body of software developed at each user's site. They are even linked to changes in the way the user does business. Business information systems are difficult to build, have proprietary DBMS technology at their core, involve close relationships between individual buyers and sellers, and are far easier to incrementally improve than to substantially replace. It was this cluster of features which led the government, in its 1953 and 1969 proceedings against IBM, to concerns about lock-in, barriers to entry, and the use (and abuse) of interface standards control. Now the DBMS itself, not just the underlying operating system, exhibits many of these features. At the present, the two most important server-side DBMS firms are IBM and Oracle. They are not without monopoly power, customer connections, nor resources.

The emergence of a series of networked computing architectures has brought MS into vertical competition with server-side DBMS vendors. For organizational computing, interorganizational computing, and electronic commerce, users demand both client-side functionality and server-side access to enterprise data and systems. Many networked computing applications call for easy connection to large numbers of people, be they employees, customers, or employees of customers or vendors. The same networked applications call for powerful server-side data manipulation. Since the early 1990s, the possibility of actually achieving this "best of both worlds" integration has been steadily improving. More and more applications are genuinely networked. Thus, the series of technical innovations beginning with simple client-server architectures and now continuing with intranets, extranets, and net commerce are increasingly proving useful to users. They are also increasingly bringing client-side dominant firm MS and server-side DBMS vendors into vertical competition. The internet-based technologies have meant new applications for DBMS, temporarily weakening incumbents' lock in. Here we have an area of computer systems development where most users need the products of MS, and also need the products of their incumbent DBMS supplier. The structure is ripe for an outbreak of vertical competition.

I summarize the server-side DBMS competition in Figure 7. Under the theory of vertical competition I described above, the situation looks promising for consumers. To be sure, the incumbent has built up a substantial lead in technology and in connections to customers. Further, the incumbent's view of appropriate market structure will impress many analysts as superior. Yet entrant MS is not uninteresting. They have been engaging in rapid technological progress to catch up. They have a very different view of appropriate industry structure - they seek to provide not only DBMS but also server OS. They have a very different view of how the product should be marketed and distributed. The entrant lacks much in the way of a marketing capability to the relevant customers. They have responded by using a version of their own, traditional, more distant model rather than attempting to clone incumbent's model. Both sides act and talk as if the situation is very conflictual. Incumbent Oracle has joined in attempts to weaken entrant Microsoft's position in MS' home (client) market, for example. Incumbent Oracle does not appear to view entrant Microsoft as quite such an easy opponent as the number of server DBMS competitors they have reduced to unimportant position. It is more likely that incumbent Oracle will win, of course, (that is always more likely) but the race is interesting.

From a societal perspective, it is hard to see a better epochal competition situation than this. The events of recent years make it clear that there will be considerable market power in server DBMS. It seems nearly certain that there will be a dominant firm. But there is a real contest for dominant position at the present.

Perhaps I have surprised you with my remark that this situation is excellent. Many analysts will say that the proposed replacement of separate DBMS and server - OS firms with a unified, more proprietary structure is bad. They will favor the continuation of incumbent Oracle against entrant Microsoft on this industry structure argument. This is an error. The reason I am so sure it is an error is that I trust the customers in the server DBMS market to make their own decisions. Customers, spending their own money, will chose between two very different structures. They may chose integration over flexibility and choice, and chose Microsoft. Or they may make the opposite choice and stay with Oracle and Unix. It would be the height of arrogance on our part to tell them to prefer the current situation over its possible replacement.

Epochal Vertical Competition on the Server Side

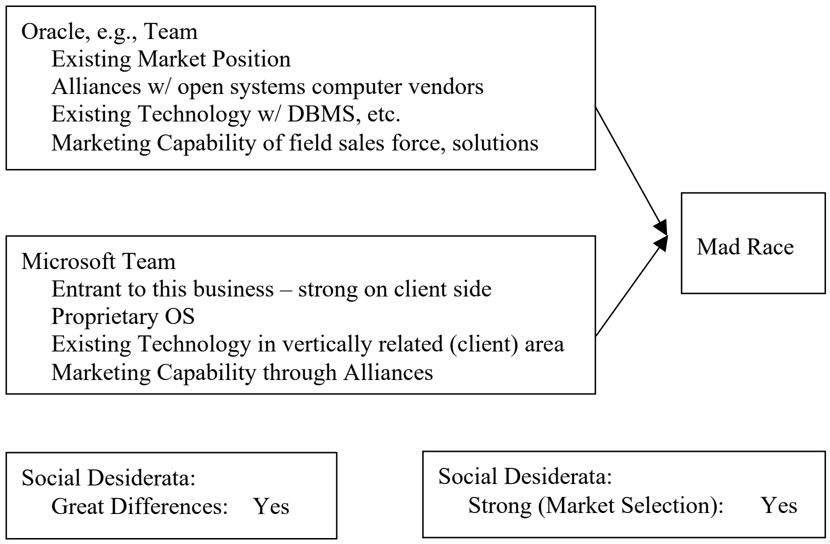

Figure 7.

4.2 Entry Initiatives on the Client Side

The big open issue in the computer business is, of course, the recent set of attacks on Microsoft's dominant client-side position. Let us examine these from the perspective laid out above.

The Microsoft client-side dominant position is inherited from its dominant position in PC software. A long series of networking initiatives - local area networks, and early client/server architectures - brought PC firms into vertical competition with networking firms. The arrival of the internet as a commercially promising technology provided the step-up to set off epochal vertical competition.

Maturation of the internet, long a technician's technology, came with the browser. Not much of a <u>technical</u> breakthrough, it was "merely" a graphical user interface to existing network resources via existing network protocols. At first, the clear uses were out of competition with existing PC, LAN, and client-server computing. Browsers offered the nontechnician access to internet resources. There were, for a while, two radically different technologies to accomplish the same thing in two closely related domains.

The MS operating system and Office suite were offered as the gateway to one set of network programs and data. The browser, perhaps to be helped by programs that would work with it, was offered as the gateway to another. Two platform-like layers in the same vertical structure with very little differentiation; it was a situation ripe for epochal vertical competition.

Thus entrant Netscape bet on the truth of George Gilder's "Microsoft is middle aged". Netscape went, sensibly, to work constructing a defensible monopoly in browsers, and extending it to server-side applications, utilities, and content. The server-side applications they developed in-house, hoping that control of the client-side browser would give them the inside track selling into some potentially quite lucrative markets, such as electronic commerce. They priced their browser for penetration and easily competed freeware and shareware products nearly out of the market. They signed up important information (content) and data-transport suppliers to exclusive contracts. It was a marvelous example of exactly the strategy that had made Microsoft rich. Penetration pricing for scale economies, control of a key interface, positioning all suppliers of complements as playing supporting roles. NS would end up in control of a defacto standard and be the main beneficiary of its network effects.

Unfortunately for Netscape, one of those complement-suppliers was Microsoft, who had earlier invented this particular game. MS proved decidedly younger than middle-aged, seeing the browser as a threat to its main source of rents and reacting with striking speed and aggressiveness. Some of MS' most impressive developers moved to internet-oriented projects. Though it started far behind, by using rapid technical progress and the made-for-penetration prices of $0, MS caught up fast.

The importance of speed-based competition is vividly present in this episode. Had MS taken a few more quarters to wake up, or been a slow software developer, they might have lost. Had electronic commerce standardized on Netscape servers a few quarters quicker, or had NS exclusive arrangements prohibitively tied up enough internet content for longer, the race could have gone the other way. As it stands, MS is the second-place browser firm and their competition has forced NS to the very competitive browser price of $0. MS has advantages that offset its second-place start, of course, such as already selling almost all browser users some software and thus having a variety of opportunities to get their product in front of potential customers. NS is a sitting duck on the client side.

Much of NS' disadvantage was related to speed as well. They needed to develop, not adapt, many technologies. They had the benefit of generations of software development in the technical internet. Thus, many difficult problems did not need to be solved. They were able to ride a positive feedback wave of considerable power. So far, so good. Developing a new platform is always a gamble, however, that the "killer application" will come along. Commercial internet applications came along, alas, with the characteristic slowness of organizational and interorganizational applications.

When the competitive attack came, then, Netscape had no systems effects in place, had not really used the positive feedback to lock in customers. To make it harder for them, almost all the new (browser) platform's head-start technologies were fully open (the internet is quite non-proprietary). On the client side, at least, Netscape was exceedingly vulnerable. And the server side was not yet established.

All this leads me to pose an impertinent question. Assume with me, for at least a moment, that antitrust intervention against Microsoft is in the interests of society. Have a vision of future competition on the client side, but it can be any vision you like. Now, wouldn't society have been better off if Netscape had been able to establish a de facto browser standard and take propriety control of it? Or if they'd had intellectual property that gave them an internet bottleneck? In either case, they'd have a far stronger position against MS, and the client-side competitive situation would be much more interesting than it is now.

My impertinent question has a point, and it is not at all the obvious one. The point has to do with the proper application of antitrust social welfare shortcut tests in the computer business. Normally in antitrust we are more suspicious of business strategies and practices when they are employed by a firm with an existing monopoly. Yet the impertinent question really raises the argument that Netscape would have been a more effective competitor if they were trying to extend a monopoly. The "has existing market power" shortcut test does not work for vertical competition. To participate at all effectively in epochal vertical competition a firm absolutely needs a reasonably defensible "home" monopoly. I raise this example not to argue either for or against intervention in the MS matter, and certainly not to accuse Netscape of monopolization. I suspect that advocates for both sides believe that Netscape's actions are (1) legal and (2) the right way for a firm in their circumstances to compete.

Do not read this as a defense of Microsoft, necessarily. My argument does not show that the antitrust problem present in all Sherman Act Section II cases goes away. Far from it! We still need to tell apart anticompetitive acts from acts of competing. Microsoft would like, by any means at their disposal, to get rid of potential client competitor Netscape. Many anticompetitive acts could be involved. Yet so to could many acts of competing, such as low prices, rapid technical progress, etc. What are we to make of such things as making the new browser highly compatible with the operating system or even integrating it in? This act has both obvious competitive elements and obvious elements of disadvantaging competitors. How to tell? Many business practices are fundamentally ambiguous from a welfare economics perspective. In much of antitrust analysis, we use market power as a shortcut or proxy way to tell socially good from socially bad uses of the practices. In the presence of market power, we infer that an ambiguous action, such as tying or bundling, might have anticompetitive intent rather than procompetitive intent. This inference is a difficult one in the best of circumstances. The policy shortcuts used to look for anticompetitive intent are poor tests in the best of cases. My argument is that they are even worse in the computer industry.

My argument does show that the traditional antitrust tests function badly in computing.[22] It may well be good public policy to tilt against MS in client-side standards races. But to do it because they have monopoly power, seems just the wrong test. They must, just as client-side entrant Netscape had to. It is the widening of the MS monopoly position over more and more layers and its potential extension into the future that is the potential problem. If the widening undercuts vertical competition, or reduces the number of independent inventive forces in the industry, it will be a serious problem. Yet the problem does not imply a solution. The right policy questions are those of my introduction: What structure do we want? Is it feasible that the structure we want can be an equilibrium? Can government intervention get us there?[23]

4.3 More Anti-Microsoft Initiatives: Thin Clients

Server-side firms find themselves in both day-to-day and epochal vertical competition with client dominant firm MS. On a day-today basis, they are pressed by MS' continuing attempts to influence interface standards. MS' entry into a wide array of server-side technologies threatens epochal vertical competition. This situation, plus MS' formidable record as a vertical competitor, has encouraged a cluster of vertical competition initiatives with a "thin client" flavor.

[22] This begs the question of when they do work. An important part of the answer is that most industries lack powerful forces for short-run monopoly in almost all their components.

[23] This begs the question of what legal authority should be used here. I find myself in the uncomfortable position of advocating discretion rather than policy rules. It seems nearly impossible to have policy rules for Section II matters, however. This stands in stark contrast to merger enforcement, where commitment to rule-based market definition would drastically lower enforcement costs while slightly reducing policy tailoredness

.

From the network computer to JAVA/RMI, all the thin client initiatives have as their main strategic goals: 1. removal of the MS client bottleneck and, 2. weakening of MS influence on network standards setting. To accomplish this, all are premised on a very different technical vision of networked computing than Microsoft's. Some propose to replace MS' position.

Thin client proponents see MS software as bloated, sacrificing performance for rampant featureiteis and sacrificing flexibility for integration. They offer an alternative vision of more smoothly interacting software components. Microsoft offers a tightly controlled proprietary standard for how different software running on different computers works together, called DCOM. While other vendors can have their software work with DCOM, its origins and strengths are in the MS office suite and the Windows client operating system. Strategically, other firms suspect that DCOM standards will always favor MS software, locking all of computing into an old technology. Sun Microsystem's JAVA programming language is an attempt at establishing a new horizontal layer -- a programming language! -- for purposes of vertical competition. Aspects of the JAVA vertical competition strategy include many of the most important and powerful elements from the now-classic toolkit.

The proposal inherent in Java suggests a very different way to control different computers' interactions in a network. The Java programming language itself is not the most critical element here. The Java virtual machine (JVM) concept shifts control of what a computer is from the designers of that computer to the designers of JAVA. JAVA programs will run the same way, so the concept goes, on any computer with a JVM. Computers -- client-side computers in particular -- become more of a commodity. For this commodification strategy to work programmers must stick with the discipline of programming for the JVM, not optimizing for the computer beneath it. At the present, of course, programmers are tempted to optimize for the most common client, Windows, and MS is happy to help them out.

That JVM discipline may have large network effects associated with it. JAVA development is thoroughly object oriented. This means that any developer who may write incremental JAVA "applets" to a networked computing application area will find it easy to interact with what is already there. Technologies for having applets interact with one another and with virtual machines permit the accretion of one and more complex elements all in a controlled and extensible way.

The JAVA system of belief, as I have described it, relies extensively on the forbidding of thick clients. A client-side operating system cannot have a complex set of programming interfaces that are specific only to it. Instead, it will communicate with the rest of networked computing only through a series of coffee-colored interface standards and related alphabet soup: JAVA beans, RMI, etc.

This is an important control shift in the direction of openness on the client-side. As a result, it has drawn extensive support from two camps. First are large, well-funded server-side firms with a strong commercial interest in vertical competition with Microsoft. These include SUN Microsystems, of course, but also IBM. Many other server-side firms and "middleware" or tools firms participate by making complements to the various JAVA interface standards. So, too, do a number of startups.

A second source of JAVA support is a gigantic grass roots movement of programmers who like open systems, dislike Microsoft, or like the new and cool. Not particularly motivated by commercial interests, this unpaid army of developers, commentators and opinion leaders is almost a religious movement. Many are internet programmers deeply resentful of what they see as an attempt to make an extremely open technology proprietary to Microsoft.

JAVA and the associated interface standards, JVM and RMI, promise to be a new platform for networked computing. The new platform has highly different technical features from the one proposed by MS. (Cf Figure 8.) This is a very encouraging start for a round of epochal competition. The visions are quite different, perhaps different enough to tempt developers and users out of their considerable investment in Windows and Office.

The first great difficulty is, of course, that JAVA is a <u>new</u> platform. Accordingly, it must start the positive feedback process from scratch. While it is encouraging to have so many resources allied behind JAVA, the problem remains of building an installed base. Wags suggest that we will run out of coffee-related words so that JAVA will die of inclarity. A far bigger problem is that practical computer systems development goes forward in the present tense. Developers see a great many Windows boxes in their environment. A typical corporate or household application development environment right now has about as many thin clients as a typical fat farm. There is the same gap between desire and reality in computer client weight reduction and human pudge control. Meanwhile, incumbent MS is doing everything it can, legal or illegal, to leave the current client situation in place.

4.4 Innovative Control System

A reason to like the JAVA/RMI/JVM entrant is that its control structure is decidedly different from Microsoft's. MS proposes a set of proprietary interface standards with a high degree of integration. The control structure centers on the lead vendor, MS. JAVA/RMI has a two-tier control structure. A central firm, SUN Microsystems, is the "steward" of the standard. Yet there is an affiliated open systems control structure in which many other vendors, users, and developers, have influence.

Epochal Vertical Competition in Clients and Networking

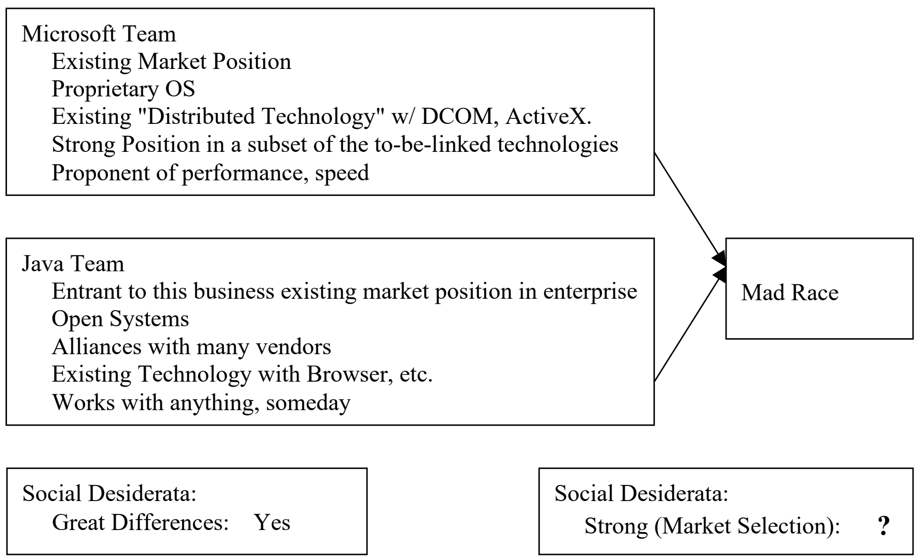

Figure 8.

These two control structures are adequately different to offer buyers a very clear choice. I think it would be arrogant to conclude that the JAVA control structure is better. Subject to a caveat I raise below, it is quite likely that industrial organization affiliated with JAVA will perform better during eras of stable structure. Yet it is not at all obvious that the open control structure will perform better in an epoch. The more open it is, the harder it is for a standard to be effectively directed and coordinated.[24] Users may prefer those attributes over the likely more inventive decentralized and uncontrolled model. Further, the open system may be at a strategic

[24] One of the most interesting developments in the theory of standards setting has to do with the strengths and weaknesses of sponsored vs. unsponsored standards. See Farrell et al. (1994).

disadvantage in an epoch if coordination costs slow it down. The issue is not for us to choose, it is for us to make sure the market has a choice. The market may like the MS version.

One other dangerous feature of a more open structure is its vulnerability to hijack in vertical competition. There are important historical examples in which an open system has proved vulnerable to competition from a closed system.[25] The fastest control system is a sponsored platform that efficiently incorporates technology developed in a number of firms.

JAVA's innovative control system appears to be an attempt to get the best of both worlds. There have already been attempts, it is claimed, to hijack the open standard, notably by MS.[26] These attempts will not end if JAVA is established as an important platform. Instead, they will be redoubled. I summarize all this in figure 8 by giving high marks to the variety of market initiatives, but low marks to the probability the market will lead the selection of a new client standard.

5. COMPETITION POLICY IN THIS DIFFICULT DOMAIN

5.1 Oddities From the Policy Debate

Section II cases are always difficult, and especially so the present one. There is a body of analysis that I think is wrongheaded but not particularly odd. Attempts to help the Government decide how much better a technology Java will be, or how much better open systems will be, are doomed to fail but not odd. Having hundreds of engineers learn about competition policy from the recent DOJ/Microsoft contract dispute was sure to lead to some confusion, but not to anything really interesting or informative. No, to see the real oddities of this case we must watch antitrust theorists attempt to come to grips with it.

[25] In the Box vs OS vs IC vertical competition of the PC business, IBM was a worthy loser to Intel and to the Industry Standard Architecture. But the ISA and the (Extended) EISA became a sitting duck for Microsoft. Similarly, highly open CP/M did not compete effectively against entrant IBM-PC in an earlier epoch.

[26] This is why there needs to be a steward, to prevent hijacking of the standard. The problem, of course, is *quis custodiet ipsos custodes?*

I was amazed to discover, at the conference that led to this book and from the recent work of journalists, that the network externalities/lock in theory is perceived as a left-wing theory in parts of the antitrust policy community. It is taken to support interventionist antitrust policy, to be a theory of why network industries' concentrated structure is socially bad. This is just wrong. The network effects theory has increasing returns to scale at its heart. The increasing returns come from the network effects immediately and directly. The increasing returns are "social," i.e., shared among users and producers of a network. See my discussion in Section 1.1, above.

These social scale economies could provide an explanation, from social efficiencies, of the concentrated structure of the layers of Figure 2. The network effects theory is fundamentally ambiguous in its welfare implications (so, too, are all theories with increasing returns at their core.) Network effects mean that the socially cost-minimizing industry structure is often quite concentrated. But they also mean that there are opportunities for individual firms to seize control of bottlenecks and extract monopoly profits. Neither the left nor the right can claim the network effects theory. It is simply a fundamental fact of the computer industry.

This misperception has led defenders of Microsoft into one of their two hilarious positions. Feeling compelled to counter the network effects theory, they argue that it is false in computing. Computer users have no switching costs of moving to a new platform, they argue, or if they did there would be no problem organizing users in a coordinated switch to a new, superior technology. This is quite literally hilarious as a defense of Microsoft. It is to Microsoft's, and to Mr. Gates', huge credit that they were the first to understand and exploit the network effects theory in personal computing. That is why the company, and its founders and other senior executives, are so rich. It is the key fact in understanding their very substantial positive contributions, including aggressive price cutting and other mechanisms as to build a large installed base, just as much as it is the key fact in understanding their monopoly power.[27]

There is another hilarious defense of Microsoft, which is that incentives for future innovation will be undercut by "taking Microsoft's intellectual property". What future innovator is going to try to become a computer industry titan, they fret, if Microsoft's profits from it's innovation are now taken away? This argument seriously needs a reality check. Microsoft is a fabulously profitable company, and its employee-owners have earned tremendous rents on their (considerable) brains, guile, technical skills and

[27] It is common in the computer business. See Greenstein (1993), Breuhan (1997.)

determination. The internet is full of business opportunities for bright young people today. The kids with dollar signs in their eyes, not just the ones with stars in their eyes, still flow to this sector. A talented kid can be quite motivated by rents in the low ten of millions, trifling as those may seem.

A truly delicious irony: attackers of Microsoft have appropriated this same silly argument. (I do have to get to Washington more often.) They fret that "venture capital for internet startups is drying up" because an unfettered Microsoft is drying up all the profits for potential competitors. An extension of this argument (I am not making this up) is that the government should protect the firms now attacking Microsoft's position because it is hard for innovative startups to obtain financing.

Neither half of this interventionist position survives a minute of comparison with reality. (1) Last year saw a new record in Silicon Valley venture capital placements, many connected with the internet. To be sure, the computing part of those is changing in flavor. But that is easily understood in terms of internet competition. The internet is rapidly (it does everything rapidly except deliver web pages) maturing as a commercial computing platform. The role of entrepreneurial startup is naturally shifting from inventors of platforms to that of specialists, extenders, inventors of new complementary technologies, and so on. These provide new layers for vertical competition with incumbents. (2) Who are these poorly-funded startup entrants? Well, Netscape Communications was a startup. But they, who hoped to commercialize the internet before Microsoft noticed them, and who embodied the "indirect entry" of internet technologies, are the exception[28]. The other contemporary thin client, directly anti-Microsoft initiatives, such as the network computer and Java, are sponsored by such well-funded and experienced established companies as Oracle, Sun Microsystems, and IBM.

Some will think that both sides in the policy debate are arguing from ideology and self-interest rather than from hard facts and data, given the sheer daffiness of the arguments. I think that there is a simpler explanation for the excesses of the arguments on both sides. Both sides would like policy to increase the rate of useful innovation. It is very difficult to see how and if policy intervention will help with that goal. Like all Section II cases, this one involves the weighing of advantages and disadvantages. Unfortunately, those are nearly impossible to assess in a hard and objective

[28] Their experience hardly speaks to the impoverishment of venture capitalists and entrepreneurs, either. Elsewhere, I address the much more interesting question of what their experience tells us about a technology-based entrant's competition against an entrenched commercial computing incumbent.

manner. So the policy community is driven to simplistic and overstated arguments. A related issue is that there is an utter disconnect between two questions: "did MS break the law?" and "can antitrust intervention improve industry performance?" Normative- and value-laden analysis is a difficult proposition in an industry like this one.

5.2 Antitrust Policy Effectiveness

Under the structural equilibrium conditions I outlined in Section I, fundamental constraints limit policy effectiveness. Let us consider the policy problem of the moment, whether and how to rein in an aggressive client-side dominant firm. The first limit is that there will be a client-side dominant firm (whether its name is Microsoft or not). It will use control of standards to push aggressively into the rest of computing (though perhaps not as effectively, for good or ill, as MS). Client-side entry opportunities will come only with big steps in technological opportunity (GUI, WWW) and even then entrants will be behind in standards races.

The good news is that entrants will still come, whenever there is a major step-up in technological opportunity. We can rely on the entrants' incentives. The private returns to dislodging a dominant position will remain fabulous. The bad news is that the likelihood of an entrant, even entrants like IBM and Sun, dislodging a client-side incumbent are low. The network effects / positive feedback conditions, plus the very high level of expertise of the existing dominant firm, give entry a low probability of success. These conditions of equilibrium are the backdrop to policy.

The backdrop to policy formation has two main implications. First, it has the implication that there is a call for realism. In the next subsection, I will briefly review the history of antitrust intervention in the computer industry. While most observers have focused on the wisdom of that policy, I look at a logically prior question: assuming that the goals of the antitrust policy were wise, did the policy do any good? This is a sobering exercise for current policy initiatives. I then take up the contemporary policy question of "what could be usefully accomplished now?" and examine several current possibilities. This is another sobering exercise.

5.3 Antitrust Policy Effectiveness so far

An extraordinary amount has been written about the desirability of the antitrust interventions that the computer industry has seen historically. Analysts tend to have seen IBM either as an evil monopolist locking in customers to let itself be a technological laggard or as a brilliant organization capable of innovation, marketing and commercialization of that innovation, and management of those two very different activities. (Cf. footnote 11.) Similar normative statements about Microsoft contend for our attention in the present. Positive before normative: what did the IBM interventions actually accomplish in terms of effects? Fundamentally, they were monopolization cases, so their effect should have been to move the structure of the mainframe business away from IBM monopoly.

The 1956 consent decree, signed just before it became clear what the computer industry was going to be like, was stunningly inefficacious in encouraging entry into IBM's markets. During the long period of IBM's dominance of commercial computing in its mainframe product lines, there was very little direct entry into competition with the firm. And what there was did not limit IBM market power in any important way, certainly did not threaten IBM control of important standards. There was plenty of entry into computing, for example in the creation of new industry categories, such as minicomputers. That entry didn't need antitrust protection, for IBM had neither the incentive nor the power to get rid of the entrants. And in the case where IBM did extend its position to (temporary) dominance of a new category, the IBM PC, the firm did it in completely legal ways. IBM's monopoly was eventually ended, by the competitive crash of the 1990s, but the consent decree did not do those entrants much good either.

No, the primary impact of the consent decree over its 1956-2001 life has been to limit IBM's effectiveness without affecting industry structure. Two examples. First, it was and is illegal for an IBM salesman to offer a price cut on a leased computer right there in the sales meeting. That is certainly not pro-consumer in its direct effects; it could only be good for society by encouraging entry. Second, IBM has been banned from vertically integrating forward into the "service bureau" business and selling the services of computers rather than computers themselves. Given that IBM's particular advantage was in service, marketing, and commercialization, this amounts to simply making what the firm does best harder to do. Again, it could only be socially useful through indirect effects, permitting entry. It didn't help the BUNCH compete against IBM very much. The ban did help in the emergence of a separate computer services industry, including systems integration, custom software, etc. This separate vertical layer obviously was an important potential vertical competitor against IBM. As it worked out, that led to considerable low-grade vertical competition, but never any serious attempt at epochal vertical competition.[29]

[29] Interestingly, relationships between IBM and large systems integrators (for example) had been co-opetitive for years before the creation of the "new" computer industry structure in the PC business.

The 1969 case, IBM-II, is comparable in that it had more impact on the structure of the dominant firm than on the structure of the industry. Ironically, IBM-II, which the government lost, probably came closer to actually influencing industry structure for the better than IBM-I. Early in the case, IBM was concerned about the possibility that some of its business practices would look bad in court. The firm opened up its mainframe architecture slightly. There were, as a result, quickly some successes in selling IBM-compatible peripherals such as disk drives and more slowly some successes in selling IBM-compatible computers.[30] IBM maintained firm control of the operating system, networking standards, etc. Fujitsu and STC represented the threat, but never the actuality, of epochal vertical competition. Of course, there was somewhat more day-to-day vertical competition with second sources of peripherals and computers available, and those sources undercut IBM's ability to price discriminate. Inside sources report that IBM also became considerably more technically and competitively cautious as a result of the prosecution. Ultimately, the case was dropped with IBM dominance of the mainframe business firmly in place.

European public policy provided substantial barriers to exit for the firms that lost to IBM. Typically playing out through procurement policy as well as competition policy, the effect of protection by individual European governments was to keep an uncompetitive European computer industry alive and sheltered from being destroyed by IBM. (U.S. procurement policy tilted against IBM as well.) Attempts to make a pan-European computer company to compete on scale economies (UNIDATA) were fruitless. These barriers to exit did not lead European firms to launch major policies and investments able to increase their innovativeness and competitiveness internationally.[31]

Both US IBM monopolization cases led to less vertically integrated structures, both by changing the structure of IBM. When the end of the IBM era finally came at the beginning of the ‘90's, it was not the industry structure changes related to the antitrust cases which were involved. IBM came under pressure from a vertically disintegrated cluster of competitors, to be sure. But those competitors came from the workstation, PC, and minicomputer businesses, not from the separate vertical layers of the

[30] Similarly, the current anti-Microsoft initiatives may have their largest and potentially most useful effects through saber-rattling rather than through actual policy intervention.

[31] Cf. Bresnahan and Malerba (1997) notably section 3.5.

mainframe business. Competition policy did little to hasten the end of the IBM era; the IBM monopoly was not ended by legal attempts to prevent IBM monopolization. It was not the vertical disintegration of the mainframe business, which the government might have fostered, but the emergence of a separate vertically disintegrated cluster of suppliers out of direct competition with IBM, that led to the competitive crash.[32]

It is important to avoid two distinct kinds of perfect hindsight / perfect foresight errors here. IBM-II's effects on industry structure, notably the ones that came from the initial shot across IBM's bow, might very well have contributed to useful vertical competition had the computer industry's history taken a different turn.[33] Yet they did not. We should not assert that the case was foolish, just because in hindsight we can see it had little effect. We should also not make the mistake of thinking that our foresight will exceed that of the generation before us, that we are capable of designing a "surgical strike" where their efforts were ineffectual.

I have already noted the ineffectiveness of MS-I. It was like the IBM cases in having no benefits, and is distinguished from the IBM cases primarily by having no costs.

The main goal of the IBM-I, IBM-II and MS-I antitrust cases were to change the structure of the computer industry to make it more competitive. They were monopolization cases. Forget for a moment whether you think that goal was wise. Why were the cases so ineffectual in reaching their main goal? There are very powerful forces behind persistent, dominant positions in computing. Eras are very hard to end. Attempting to reduce barriers to entry when the incumbent is stronger than the potential entrants may not lead to any structure change. The only serious opportunities for radical industry structure change come from indirect entry, that is, they cannot reasonably be foreseen. Even substantial impacts on the structure of the dominant firm, as those imposed by consent decree in IBM-I and those imposed by threat of prosecution in IBM-II, may fail to have any impact.

[32] I should disclose at this juncture that I worked with IBM's attorneys on IBM-I, redux, the 1990s portion that led to the eventual agreement to end the 1956 consent decree.

[33] For example, Japanese mainframe manufacturers took a series of increasingly ambitious shots at IBM. One of these might usefully have succeeded. Cf. Bresnahan and Malerba (1997).

5.4 Policy Goals for Contemporary Antitrust

Could we do better in the present? How will the constraints imposed by market forces matter? To be realistic about computer industry competition policy, we must recognize that powerful forces affect this industry's structure. Many computer technologies are going to be supplied by only a few firms, often primarily by a single dominant firm, however competition policy works. Attacks on incumbent dominant firm positions will usually be low-probability-of-success undertakings, however competition policy works. Dominant firms in particular technologies -- client operating systems, for example, or server database management systems -- will attempt to extend their strong positions to include more technologies. These structures and competitive behaviors are all givens. The issues facing policy makers are not, in the first instance, ones of the desirability of intervention. They are issues of policy efficacy.

Though we can expect most dominant firm positions in computing to be long-lived, there are opportunities for competition (a) to improve the innovative behavior of dominant firms and (b) replace dominant firms should they grow distant from customers or technologically lazy. The replacement opportunities will not arise with great frequency. Punctuated equilibrium in computing has its own logical timing. But there can be a role for policy with the right timing, and a useful role with the right humility. In this subsection, I quickly examine the main alternatives.

One (modest) policy goal would be to make the threat of entry more effective. Entrants need not actually displace dominant firms, but instead offer strong incentives for rapid innovation to maintain the dominant position. The dynamic industry structure would have a persistent dominant firm and a series of entry threats. Consumers would get the benefit of expanding technological opportunity through the incumbent's innovation. Consumers would not lose their investments in platform-specific investments.

I say this policy goal is modest not because I think that the outcome I just described is bad. Given the fundamental constraints, this may actually be the optimum outcome from a policymaker's perspective. No, it is modest because, on the client-side of networked computing, this policy goal has already been achieved. Say what you like about Microsoft's use of other entry-preventing strategies, their reactions to the recent series of entry threats have been technologically highly aggressive. Within the limits imposed by preserving Windows platform compatibility, they have been highly innovative. They have made their products work well in completely new environments, such as the internet. They have aggressively cut prices where there is a competitive threat. The current industry structure, plus the continuing series of step-up technological opportunities, have produced an awake and active dominant firm. Of course, MS has also aggressively used a great many other avenues, less valuable ones socially, in response to entry threats. But if the question is one of disciplining a dominant firm, the answer is obvious. There does not appear to be any shortage of innovative incentives for the incumbent dominant firm that arises from its strong position. If anything, the mystery is to explain the degree to which MS acts as if it believes the dominant position could be swept away in a moment. One could hardly wish for a more effective role for threats of competition in disciplining a dominant firm.

The more ambitious goal for policy would be substantially raising the probability of an entrant dislodging an incumbent dominant firm if the entrant has superior technology or business acumen. The client side of networked computing has not had many such replacements lately. The round of replacements of incumbent dominant firms -- IBM, WP -- by entrant Microsoft was the end of that. Incumbent Microsoft, with the aggressiveness just described, has yet to be dislodged from positions of control. We could imagine, therefore, an antitrust authority which would like to lower the probability of MS continuing. Sensible public policy considerations do not make lowering that probability a goal in and of itself. Instead, they make it a reasonable goal if, along with the increased chance of dominant firm turnover, there is a reasonable chance of better performance in the future.

The important current initiatives involve replacing the Windows platform with another platform, either on the client or in the connectivity between client and network or both. The open questions, then, are about the industrial organization of the new platform, the technology associated with the new platform, the costs of abandoning or seriously lowering the importance of the Windows platform, and so on.

Running a race for a platform replacement is a very serious business. It is completely impossible to say that society will be better off with a replacement. But it is possible to say that encouraging a race, even tilting to the platforms which are behind, is a good idea. The first question for policy makers is whether the race is worth running or influencing.

Here the basic structure desiderata are: 1. very substantial differences between entrants and incumbents in technology and/or business model, and 2. a strong market selection mechanism that effectively aggregates customer's demands.

Desideratum (1) has its roots in the economics of standards. We are contemplating abandoning considerable investments in an existing platform. The alternative should be quite different. Note that the alternative offered by the entrant need not be known to be better. Indeed, it is not the proper task of the policymaker to decide whether the entrant's offering is better. That is the job of the market. If, however, the policymaker reaches the reasonable judgement that the entrant's offering is different, and credibly commits to letting the market do its part of the selection job, there is a good chance that running the race is a socially valuable proposition[34].

I hold back from having the competition authorities pick winners for two main reasons. Policy formation is difficult, and policy formation has systematic errors.

5.5 Policy Formation is Difficult.

Tipping to a new platform standard in commercial computing really is a mad race. At the time policy can be effective -- early in the standards race -- it is extremely difficult to forecast the future. Brilliant people are about to invent a great many new things, which will interact in a complex system to determine the outcome. No one, and certainly no policy making-body, has the cognitive capacity or the knowledge to pick "better".[35] This first point is uncontroversial, though it may be difficult for Washington insiders to admit it. The market needs to be supported, not replaced, in standards races.

We experts have reason to be humble in forecasting the outcomes of these races early on and to leave a substantial amount of choice to the market. The issues involve at least three very difficult tradeoffs, exactly the kind where you want people spending their own money to be decisive. These are

1. Backward compatibility vs. technological breakthrough: the basic economics of standards means that users should have a large role. Backward compatibility is not free, for respecting it means foregoing new technological opportunities. Breakthroughs aren't free, either, if they mean abandoning existing investments by users that are specific to platforms. These are very complex decisions, especially in organizational and interorganizational computing. The costs and benefits of a standards switch are hard to evaluate, the proper province not of the government but of buyers.
2. Coordination vs. Choice. Not all buyers of IT like the vertically disintegrated market structure of the PC world, particularly not for

[34] I have abandoned a rules-based antitrust analysis here in favor of a discretion-based one in this section. This is correct, and troubling, but arises from the structure of Section II cases.

[35] This argument was first made by David [1986].

complex organizational and interorganizational applications. They are less than completely convinced that the shift reported in Figures 1 and 2 was a good idea. They recall some aspects of the IBM system, notably the single vendor's responsibility for reliability and for technical coordination, with fondness. This is another very difficult tradeoff. Who should make this particular choice? I would venture the opinion that the competition policy community thinks more clearly about the industry structures that lead to choice and the value of that choice than do most business people. On the other part of this choice, I don't think anyone, the policy community least of all, understands the structures that lead to effective technological coordination, or the relationship between vertical disintegration, speed of technical progress, and coordination. New ways of organizing companies and clusters of companies are being invented for the purpose of serving the computer market. It would be the height of arrogance to forecast which of them will perform well. To reach that judgement, we need market input, the judgements of customers laying down their own money.

3. Very different technical visions. Vertical competition comes not only with a race for control of interface standards, but also with very distinct technical visions. The race and the technical vision are often linked. The current race to establish networking computing interface standards has a "thin client" technical vision being offered in contrast to the reigning "thick client" vision.

Vendors with existing client-side technologies tend to bet on the "thick" model, while those with strong server-side technologies take the opposite bet. Vendors' predictions of the technological future are made in a very uncertain environment. They tend to be millennial, photogenic, and a bit self-serving. Using vendor input plus expert opinion to decide among alternative technological futures is extremely difficult. The information needed to decide on the appropriate technological direction is very difficult to understand, and key parts of the information are proprietary. Rather than being secret, the proprietary parts are spin controlled by interested parties. These are bad conditions for collective decision making; the individual decision with money on the table is the best option.

5.6 Policy Formation's Systematic Errors.

My second cluster of reasons for preferring market selection are more controversial, but worth examining. The public debates over computer industry competition policy, and public policy formation, have exhibited three systematic biases over a long period of time. These make me very eager to ensure that the selection mechanism we use have strong market elements, not just input from pundits, experts, and officials.

The first two biases of public policy formation come from the same source, an unrealistic and even romanticized vision of the innovation process. Both start with the correct argument that an important policy goal is the rate of innovation in high tech industries. Both then draw incorrect conclusions from it.

1. Marketing isn't useful fallacy.

Oh, how rapidly we could innovate if we didn't need to make our innovations useful to customers! Every dominant firm in computing has been accused of "just" marketing, while the true technological innovation goes forward elsewhere. In the present, we have the "Windows 95=Macintosh 89" bumper sticker, while the past gave us the same accusation about IBM. This is romantic drivel, and it is dangerous. Making raw information technology useful is a key part of the IT innovation process.[36] Marketing capabilities are a key to vendor company success. They are not just a mechanism to extract rents but also a device to lower adaption costs and to guide the direction of technical change.

2. "Best technology" fallacy.

A related bias comes from forgetting the social costs of moving the installed base to a new platform. We often conceptualize users as locked to an abusive dominant firm, blocking real innovation. To users, however, raw technical advance is most valuable if it does not render existing platform-specific investments obsolete. There is a tremendous benefit of platform continuity to users. Public debates focus excessively on the new and cool, too little on the practical.

The final systematic bias has two variants, depending on where you live.

3. Americans are arrogant fallacy.

To all but one of the many governments that have sought to protect competitors from computer industry dominant firms, the American-ness of those dominant firms has been the most common argument. We Americans are arrogant, youthfully brash, uncultured, unaware of the subtleties of interaction and business. While it may be true, this is not much of an

[36] To decide that marketing capabilities should not count in deciding which firm(s) should succeed in IT is to sweep away a breathtaking amount of research and common sense. It is, for example, to decide that there have been no difficulties in making computers productive. Over the entire range of opinions in the computerization and productivity debate, you will find no one who thinks that making them useful is a triviality. The organization of the IT selling sector to support the IT using sectors is socially very important.

argument for anti-American protectionism. This particular argument has a domestic variant , as well, the

4. Success breeds arrogance fallacy.

American governments have found it difficult to be anti-American, so they have typically been anti-success in aligning their competition policies with European ones.[37] Of course success breeds arrogance, but that is not much of an argument for tilting against successes.

These arguments are carriers for a systematic anti-incumbent, anti-success bias. The thing to remember is that the likely successors to Mr. Gates and Mr. Grove, the shared monopolists of the moment, are just as arrogant and significantly more American.

These three biases do not imply that there is no role for government policy. Rather, they mean that market selection should have a very substantial role.

5.7 Policy Alternatives

Finally, let me return to the question of policy feasibility. What does my analysis suggest about the effects of different degrees of policy intervention? Is there a policy stance which can avoid the disadvantages of lock-in by offering computer users more real choice? Or is the only available policy that of picking winners outright? In this section I search for a middle way. This, too, is a sobering exercise.

Much of the public debate acts as if the goal of competition policy is to pick winners. I include in this category all griping about and defending of Microsoft products, and all discussion of the benefits and costs of integrating a browser into a client OS.[38]

The real policy issues have to do with whether a tilt to the anti-MS forces will have any real effects, and if so, whether those effects can be reasonably forecast to be desirable if customers take advantage of them.

There is, of course, a near continuum of policy remedies available. Let me anchor that continuum with a table that might illuminate the tradeoff. Toward the top, we have the remedies which involve the least harm and the smallest risk. They are not particularly intrusive, and they are closely related to MS' worst excesses as a competitor. As we move down the table, the remedies get more distant from MS' excesses and also get more intrusive.

[37] See Bresnahan and Malerba (1997) on governments

[38] I count these as part of picking winners because they involve assessing MS' performance.

My concern is that the remedies start out ineffective and end up risky.

5.7.1 Simple remedies ineffectual.

Suppose that a wide variety of MS business practices were banned. I mean not only the practices that are associated with clearly illegal behavior, but also many practices that appear to be coercive, exclusionary, etc. Many of these are related to the new economic role of sellers of PCs as a distribution channel. Specializing in assembly, logistics, and the like, these firms are the way that the MS operating system is delivered to its customers. So many kinds of exclusive dealing might be banned: we might prohibit any control of the desktop of a Windows computer as delivered, for example, by MS.[39] This would certainly remove any opportunity for MS to control access to content providers and service providers through its client-side position. It would take away some of the tools MS uses to discourage the use of competing browsers. In the future, if Java becomes more of a platform, banning MS exclusionary practices might make it harder for that firm to keep Java from getting established.

How effective would banning those practices be? It would still be perfectly legal for MS to give away its own browser for free. In a "practices" case, it would be perfectly legal for MS to have its own browser more and more integrated with the operating system, with the Office suite, etc. Meanwhile, it would still be perfectly legal for MS to undertake all the other tricks that it sometimes uses to bedevil competitors. It would be perfectly legal to spend tens of millions of dollars per product to make sure that MS products are, feature-for-feature, ahead of the nascent browsers, Java platform components, etc. It would be perfectly legal to bribe "thought leader" customers to undertake innovative development projects based on MS technology. It would be perfectly legal to offer million-dollar signing bonuses to key technical personnel at competitors. Last but not least, it would be perfectly legal for MS to continue to be very good at the socially positive things it already is very good at.

The problem is, under the best theory of the case for the government and Netscape, MS is willing to pay up to the present discounted value of the Windows monopoly to prevent entry. That is a very large sum, indeed. Further, we are talking about an epochal race to establish a new platform standard. Those go, systematically, to the firm that is ahead in technological

[39] The easily recognizable structure here makes it obvious that we don't need a "new antitrust" to deal with this industry, just application of familiar principles in a new domain.

or market position or in resources. Taking away some of the tools that MS uses – the ones that are illegal or nearly so – still leaves epochal competition with its law of network effects in place. There is an excellent opportunity for a practices case, even a quite intrusive one, to have the effects of 1. slowing the exit of the losers in the epochal race, 2. making the policy community think it has done something useful and 3. leaving future industry structure just as it would be otherwise.

5.7.2 Effective Remedies Risky

Now, as we get toward the bottom of the table we find riskier policy initiatives that have the prospect or the possibility of both larger costs and larger benefits. The manipulation of private information about standards formation is a powerful MS tool. Taking that away -- by forcing a change in the boundary of the firm-- might well affect outcomes. Here the problem is the nearness to picking winners. The government could say that the problem is an excessively vertically integrated, inward-looking structure on the client side. It could open up that structure either informationally or by breaking up the firm. These decisions might well be efficacious in at least raising the probability of MS losing the next standards epoch. Unfortunately, they achieve this by (1) taking away MS most anticompetitive tools (this part is good) which are also (2) the keys to MS' particular strength. It is flat-out picking winners.

The basic problem is, as we go down Table 1, the iron logic of network effects is with us. We start with "practices" initiatives that will change the probability of a concentrated industry structure only trivially. That is how network/effects positive feedback systems work. If you give them only a modest nudge, they tend to not change very much at all. Lower in the table are policy initiatives that give the system more of a kick. They might change something, might push the system over a hump.

Many will read this section as pro-Microsoft, which is wrong. I stand by my 1991 metaphor for this case, that of the dog and the firetruck. We have on the one side, a dominant firm which has not yet matured into the role. There is some hope that the unhappy events of this winter will have helped with maturation, but no certainty. They, Microsoft, are the firetruck. We also have the prosecutor and political supporters salivating at the prospect of a chase. Looks good. Right down the middle of the street, loud, red, crowd already assembled. But gentlemen, what are you going to do with it when you catch it?

Table

Selected Policy Options	
Practices-Light	Enforces a ban on MS practices that are clearly problematic for competition, such as the single-processor license.
Practices-Heavy	Extend the ban to a wide range of MS business practices which are not themselves likely to be bad, such as • banning all exclusive dealing • permitting computer manufacturers to control desktop icons • etc.
Structure-Light	Substantially alter the conditions of ownership of MS intellectual property, • require public access to the details of the interface specifications of new MS product releases. • ban selected ties, bundles, and integration of MS products
Structure-Heavy	Break up MS, • split client applications from client OS.

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