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Network Effects, Microsoft, and Antitrust Speculation

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Executive Summary

The Justice Department and other parties that have aligned against Microsoft have invoked novel economic theories to justify new antitrust doctrines and to revive old ones. Those theories imply that in high-technology markets, a product or technology with a head start or large market share may have an insurmountable advantage over its rivals. The theories invoke factors called network effects, increasing returns, or path dependence. Any of those can allegedly create lock-in, leaving markets stuck with inferior products or technologies. But these theories leave out important elements of real-world markets. Reexamination of the empirical evidence demonstrates that the claimed examples of lock-in are not market failures.

Scrutiny of the economic theories brought to bear against Microsoft show similar failings. Despite allegations that Microsoft uses lock-in to engage in exclusionary and predatory business practices, exclusion and predation do not explain its behavior. Furthermore, antitrust enforcers should not focus on who has the right to control the Windows desktop. Such a right matters little because consumers can alter the desktop quite easily. At any rate, the market will eventually put desktop rights in the hands of those who value them most. Finally, progress in software inevitably involves increased functionality. A legal rule against adding functions to software products would impede progress in the software industry.

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Introduction

Revolutions in science and technology, while benefiting large numbers of people, also bring various stresses. New technologies can alter the scale of business activities, the geographic distribution of those activities, the types of firms that are involved in production and distribution, and the distribution of wealth. The benefits are many: consumers may enjoy cheaper goods and new products; firms that implement the new technology may make very substantial profits; and workers may enjoy higher wages, new types of careers, and generally expanded opportunities. At the same time, some businesses and workers will lose out as new skills and methods of commerce supplant old ones.

In such circumstances, interested parties have often enlisted legislation or regulation to preserve old interests or defend new ones. The historical motivations for U.S. antitrust law have been at least in part an attempt by various parties to defend their stakes in the economy. The antitrust debates over new computer technologies in general, and Microsoft in particular, are consistent with that pattern. In particular, today, as in the past, there are calls for restrictions on the leading firms in new technology industries. While Microsoft is the current focus of scrutiny, the effects are likely to reach much further. As with past generations of antitrust law, the precedent and enforcement practice reached in the current debate are likely to have a wide and long-lasting influence.

In the policy debates surrounding the antitrust campaign against Microsoft, the Justice Department and other parties that have aligned against Microsoft have invoked novel and incomplete economic theories to justify action against a firm with a large market share. In markets for high-technology products, it is alleged, a company with a head start or the largest market share will have what may prove to be an insurmountable advantage over its rivals. Those new theories are associated with terminology such as increasing returns, network effects, path dependence, and lock-in.

According to those theories, where industries exhibit increasing returns, certain old-fashioned beliefs about market outcomes and market processes should be cast aside in favor of the following: First, the success of products in the marketplace comes from size, good timing, aggressive strategies, or luck, rather than their inherent values. Second, we should have no confidence that new prod-

ucts, technologies, or standards should be able to displace their established counterparts, even if they offer important advantages. Finally, and perhaps most directly of interest to the antitrust enforcers, any action taken by a market leader that might increase market share, such as lowering price, should receive heightened scrutiny, since such actions have the likely consequence of locking out superior products.

Widespread acceptance of such theories would necessitate a radical rethinking of antitrust policy. Further, such theories appear to hold considerable sway in today's antitrust debates. For example, Business Week reported:

> Instead of basing his attack against Microsoft on outdated economic theories that demonize bigness, Assistant Attorney General Joel I. Klein is relying on a developing body of antitrust thinking that warns that the threat of anticompetitive behavior could be even greater in high technology than in traditional industries. This research on "network externalities" deserves to be taken seriously. . . . The Microsoft case is one of the first ever in which Justice has made use of network theory.[1]

Even a writer at the Wall Street Journal, a publication not known for embracing radical expansions of antitrust law, has fallen for lock-in theory. Alan Murray recently opined, on the paper's front page, that

> high-tech industries might be more susceptible to antitrust problems than their low-tech brethren. That's because consumers often feel a need to buy the product that everyone else is using, even if it isn't the best, so their equipment is compatible. Economists call this "network externalities."
>
> It's why most people use a keyboard that begins clumsily with the letters QWERTY; why most videos are now available only in VHS format; and why Windows has become the dominant operating system.[2]

The new theories provide a convenient solution for those who would bring antitrust claims to bear against market leaders such as Microsoft. Those "outdated economic theories," dismissed so cavalierly in the Business Week article, might fail to support antitrust enforcement against the current generation of market leaders in high-

tech industries. Standard theories of monopoly, which have long provided what economic foundation there was for antitrust, hold that a monopoly restricts output in order to elevate prices. Monopoly was bad only for those reasons. In contrast to that concern, what we seem to see in high-technology markets are falling prices and increased quantities, even as market shares of the market leaders become extremely large.[3] Absent an allegation of high prices, antitrust authorities have looked to the new lock-in theories to provide some economic support for their actions against high-technology firms.

The problem is that the new economic theories are fundamentally flawed. Our writings, which have appeared in academic journals since 1990, show that the case for lock-in is an extraordinarily weak one.

While our work has criticized lock-in theories as being based on overly restrictive assumptions, the more telling criticism has to do with the lack of empirical support for those theories. Alleged examples of lock-in seem, when scrutinized, to be more the products of wishful thinking than the fruits of serious study. This study reviews the case against the economic theory of lock-in and analyzes the lock-in claims leveled against Microsoft in recent months. With regard to Microsoft, as elsewhere, neither theory nor fact supports the call for antitrust enforcement measures.

The Economics of Increasing Returns, Network Effects, and Path Dependence

A closely related group of ideas comes together under the theory of lock-in. Increasing returns are said to occur wherever the net benefits of an activity increase with the scale of the activity. Within a firm, increasing returns are present if the average cost of producing goods decreases as the output of the firm increases. All firms are thought to have increasing returns at outputs that are small. Economists have also long considered cases in which increasing returns are more persistent, such that even if a single firm were supplying the entire industry demand, it would still experience decreases in average costs as output increased. In such a case, known as natural monopoly, monopoly is the likely evolution of a free market. Further, in this instance, monopoly offers society the opportunity for the lowest possible production cost because it takes full advantage of decreasing costs: in that instance, monopoly is socially desirable. The prob-

lem, however, is that even though such a monopoly would minimize costs, it would be expected to restrict output and elevate prices.

Many industries regarded as experiencing such persistent economies of scale are treated as public utilities: electricity, telephone, natural gas, cable TV, and others. The policy response has been price (or rate of return) regulation. It is interesting, particularly in the context of the antitrust debate over operating systems, that the industries that we have traditionally regarded as natural monopolies are now being widely deregulated.

Network effects, sometimes called network externalities, may be understood as a special case of increasing returns. With a network effect, the benefit that someone gets from purchasing a product depends on the number of other users of the product. For example, people who buy fax machines will find them to be more valuable as other people buy compatible fax machines. The relationship to increasing returns is straightforward. As a product becomes more popular, it will become more valuable to consumers, giving it an increasing advantage over its smaller rivals. As a result, smaller rivals are likely to disappear. We may settle on a single format for videocassette recorders or a single communication protocol for fax machines. That need not constitute a monopoly in the usual sense of a single firm, depending on ownership of the standard, but in many cases it will.

As is the case for natural monopoly, a monopoly outcome may be socially desirable. That observation is critical for consideration of antitrust policies. Of course, the potential for monopoly price elevation still applies, and if it occurred, such price elevation might result in social losses. That has not been the concern of the network externality literature that apparently has influenced the Justice Department and others, however.

The problem of path dependence, or lock-in, begins with the observation that monopoly is a likely outcome of network effects. The concern then shifts to whether the best technology or product is chosen. The literature then alleges that we are likely to get the wrong monopolist, producing the wrong product, rather than a monopolist charging the wrong price or producing the wrong quantity.

Theories of Lock-In

A useful starting point for understanding the lock-in theory is an example presented by Brian Arthur, one of the leading figures in the literature of lock-in. Table 1 presents his example.[4] In Arthur's table, society has an opportunity to develop one of two technologies. For each technology, the greater the number of adopters of the technology, the greater the payoffs to those adopters. Network effects, for example, could cause this relationship.

Individuals make decisions based on their private interests and receive payoffs as shown in the table. The first adopter of technology A would expect a payoff of 10. Similarly, the first adopter of technology B would expect a payoff of 4. Under those circumstances, Arthur notes, the very first adopter of any technology would certainly choose A, thus receiving 10 instead of 4. A second adopter would reach the same conclusion, and so on, since the advantage of technology A over technology B would only increase with additional adoptions of A. But notice that if the number of adopters eventually becomes large, technology B offers greater payoffs. Thus for Arthur, the table tells a story of lock-in to an undesirable outcome.

There are problems with the table and the lessons that are drawn from it. First, note that the increasing payoffs in the table must be stronger for B than for A if the story is to unfold as presented. Yet there is no reason to think that among competing technologies the one with the greatest payoffs with many users does not also have greater payoffs with smaller numbers of users. At a minimum, that restriction narrows the set of possible lock-ins.

Table 1
Adoption Payoffs

Number of Previous Adoptions	0	10	20	30	40	50	60	70	80	90	100
Technology A	10	11	12	13	14	15	16	17	18	19	20
Technology B	4	7	10	13	16	19	22	25	28	31	34

Also, the table does not allow adopters to anticipate or influence the outcome, although people clearly do both. If the first person faced with the opportunity to purchase a fax machine had assumed that he was going to be the only user, we would still be waiting for the technology to catch on. If a technology is owned, the owner of the technology may assure adopters that they will receive the highest available payoffs by leasing applications with a cancellation option, publicizing current and planned adoptions, or simply bribing adopters with low prices or other compensation. Of course, the owners of both of those technologies can do this, but the owner of the technology that creates more wealth can profitably invest more to win such a contest.[5]

Lock-in theory is often argued in the context of formal models with multiple equilibria. In such models, several different outcomes are equally likely, even though they may not be equally desirable, and the choice among them is largely a matter of coincidence. Better products, it is shown, may not win. All of that comes to us dressed in the full rigor of mathematical proofs, supported by theorems on stochastic processes.[6] Those models, although more complex than Arthur's table, again abstract from most of the things that companies do to win technological races and most of the things that consumers do to purchase well.[7] Inclusion of those factors is difficult and cannot prove that markets always choose correctly. Therefore, whether we are considering the increasing returns story of Table 1 or multiple equilibrium models, we are left with an empirical question: Have the models captured something important about the way that markets work? The next section addresses that empirical question.

Evidence for Lock-In in the Economy: Do We Get the Wrong Monopolist?

Facts, or empirical evidence, must be the final arbiters of those theories, as they are of all theories. Given the extensive publicity surrounding these theories, one might conclude that a large body of evidence supports them. Nothing, however, could be further from the truth. The little support that has been offered consists of a few key examples of markets that have supposedly settled on the wrong system or standard and failed to change to a purportedly better system or standard. The following subsections address those examples.

The Qwerty Keyboard

The most commonly cited example in the network-externality, path-dependence literature is the prosaic typewriter keyboard.[8] The importance of that example can be gleaned from Paul Krugman's 1994 book, Peddling Prosperity.[9] In his book Krugman speaks glowingly of the entire literature in a chapter titled "The Economics of QWERTY." He does, however, appear to have altered his views when made aware of the facts presented below.[10]

QWERTY refers to the letters in the upper left-hand portion of the typewriter (and computer) keyboard. The received story is that, by slowing typing speed, the QWERTY arrangement was able to minimize the problem of jamming keys in the first typewriters. The story continues that QWERTY's ascendance was due to a serendipitous association with the winner of a famous typing contest who by happenstance used the then-innovative touch-typing method on a QWERTY keyboard.

The QWERTY design is reputed to be far inferior to the "scientifically" designed Dvorak keyboard, which allegedly offered a 40 percent increase in typing speed. Supposedly, the Navy conducted experiments during World War II demonstrating that the costs of retraining typists on the new keyboard could be fully recovered within 10 days. The story is claimed to validate path dependence: no typists learn Dvorak because too many others use QWERTY, which increases the value of QWERTY all the more.

That is an ideal example because the number of dimensions of performance is small, and in those dimensions, the Dvorak keyboard appears overwhelmingly superior. Yet upon investigation, the story appears to be based on nothing more than wishful thinking and a shoddy reading of the history of the typewriter keyboard. The QWERTY keyboard, it turns out, is about as good a design as the Dvorak keyboard and was better than most competing designs that existed in the late 1800s when there were many keyboard designs maneuvering for a place in the market.

Ignored in the stories of Dvorak's superiority is a carefully controlled experiment conducted under the auspices of the General Services Administration in the 1950s comparing QWERTY with Dvorak. That experiment contradicted the claims made by advocates of Dvorak and concluded that retraining typists on the Dvorak keyboard made no sense. Modern research in ergonomics also finds little advantage in the Dvorak keyboard layout, confirming the results of the GSA study.

So on what bases were the claims of Dvorak's superiority made? Critical examination shows that most, if not all, of the claims of Dvorak's superiority can be traced to the patent owner, August Dvorak. His book on the relative merits of QWERTY and his own keyboard is about as objective as a television infomercial.

The wartime Navy study turns out to have been conducted under the auspices of the Navy's chief expert in time-motion studies--Lt. Comdr. August Dvorak--and the results of that study were clearly fudged. There is far more to the story, but it all leads to the conclusion that the QWERTY story qualifies as no better than a convenient myth.[11]

The acceptance of that story, wrong in almost every detail, illustrates both the desire of path-dependence theorists for empirical support and their reluctance to check the facts. The economic historian who wrote an influential paper on the keyboard story and who cited the Navy study to provide support for path dependence theories never actually examined the Navy study.[12]

We published a very detailed account of that in the spring of 1990.[13] Yet in spite of our paper, which has not been factually disputed, economist Garth Saloner, who is certainly aware of our paper, used the keyboard example as recently as last fall at Ralph Nader's anti-Microsoft conference.[14] One could hardly find better evidence of the theory's lack of empirical support than the continued use of a result that is known to be incorrect.

Beta-VHS

The second most popular example of how markets allegedly get locked into poor standards is the Beta-VHS videorecorder format struggle. It is sometimes claimed that Beta was a better format and that VHS won the competition between formats only because it fortuitously got a large market share early in the competition with Beta. That story turns out to be just as inaccurate as the keyboard story.[15]

In 1969 Sony developed a cartridge-based videorecorder, the U-matic, which it hoped to sell to households. Because other companies were also working on such products, Sony invited Matsushita and JVC to produce the machine jointly and to share technology and patents, which they did. Sony hoped by its behavior to achieve a stan-

dard, which implies considerable foresight on the part of the market participants. The U-matic failed, however.

In the mid-1970s Sony developed the Betamax. Sony demonstrated the machine to Matsushita and JVC and disclosed technical details, hoping to establish a new set of agreements. Months later, when JVC demonstrated its new machine to Sony, Sony engineers concluded that JVC had expropriated their ideas. The resulting bitterness left Sony and Matsushita-JVC to go their separate ways.

The only real technical difference between Sony's Beta and Matsushita-JVC's VHS was the manner in which the tape was threaded and, more important, the size of the cassette. Sony believed that a paperback-sized cassette, allowing easy transportability (although limiting recording time to one hour), was paramount to the consumer, whereas Matsushita believed that a two-hour recording time, allowing the taping of complete movies, was essential. The larger VHS tape meant that for any given state of recording technology, VHS machines could provide longer playing time, or higher quality playback, or some combination of the two.

The behavior of the antagonists in that competition is a wonderful example of forward-looking behavior. They used partnerships, advertising, pricing, and any other tool at their disposal. The behavior was nothing like the passive adoption story that the theoretical models of lock-in present.

In an attempt to increase market share, Sony contracted to have its Beta machines sold under Zenith's brand name, a highly unusual move for Sony, and licensed the format to Toshiba and Sanyo. To counter that move, Matsushita allowed RCA to put its name on VHS machines and brought Hitachi, Sharp, and Mitsubishi into its camp. Sony slowed tape speed to increase its playing time to two hours; VHS did the same and increased playing time to four hours. RCA radically lowered the price and came up with a simple but effective ad campaign: "Four hours. $1000. SelectaVision." Zenith responded by lowering the price of its Beta machine to $996.

The market's referendum on playing time versus tape compactness was decisive and rapid. Beta had an initial monopoly for almost two years. But within six months of VHS's introduction in the United States, VHS was outselling Beta. Those results were repeated in Europe and Japan. By mid-1979 VHS was outselling Beta by more than two to one in the United States. By 1983 Beta's world

share was down to 12 percent. By 1984 every VCR manufacturer except Sony had adopted VHS.

Not only did the market not get stuck on the Beta path; it was able to make the switch to the slightly better VHS path. Although Beta was first, VHS was able to overtake Beta very quickly. That, of course, is the exact opposite of what path-dependence theory predicted: that the first product to reach the market is likely to win the race even if it is inferior to later rivals.

Now listen to the version of that story found in Brian Arthur's work:

> Both systems were introduced at about the same time and so began with roughly equal market shares. . . . Increasing returns on early gains eventually tilted the competition toward VHS: . . . if the claim that Beta was technically superior is true, then the market's choice did not represent the best outcome.[16]

The story is little more than an inaccurate anecdote. The elevation of poorly researched anecdotes to the category of "proof" for narrowly constructed theories reappears in the current discussions surrounding Microsoft, as shown below.

Other Purported Examples, Including the Macintosh

Path-dependence advocates have sometimes claimed that the continued use of FORTRAN by academics and scientists is an example of getting stuck on a wrong standard. One doesn't have to browse through too many computer magazines to realize that FORTRAN was long ago superseded by languages such as Pascal, C, C++, and now, perhaps, Java. Individuals continue to use Fortran, not because they want to be like everyone else, but because the cost of switching is too high. Network effects, as normally modeled, should have induced them to switch years ago. That is a story of ordinary sunk costs, not of network "externality" or other market failure.

Path-dependence proponents have also sometimes claimed that the gasoline-powered engine might have been a mistake, and that steam or electricity might have been a superior choice for vehicle propulsion. That is in spite of the fact that in the century since automobiles became common, with all of the applications of motors and batteries in other endeavors, and with all the advantages of

digital electronic power-management systems, today's most advanced electric automobiles do not yet equal the best internal combustion automobiles of the late 1920s.

The most captivating of those other stories, however, is the success of the PC over the Macintosh. Mac users naturally favor the claim that they chose operating systems wisely whereas the rest of the world ignorantly opted for Microsoft's products. The presence of that large and somewhat embittered audience probably explains why the idea of getting stuck with an inferior product resonates so strongly in the Microsoft case, playing as it does in the arena of personal computer aficionados.[17]

Yet even here the facts do not support the lock-in thesis.[18] Yes, Macintosh owners were forward looking when they made their purchases in the early and mid 1980s. At that time, the advantages of a graphical interface were clearly understood, if not fully implemented. The lack of implementation, however, had to do with the high price, in terms of speed and cost, that owners of graphical computers had to pay at a time when processors were slow and memory was expensive.

A graphical user interface requires considerably more power to get the job done, significantly increasing costs when that power is hard to come by. Macintosh owners had to wait for their screen displays to change, whereas PC owners had almost instantaneous updates.[19] True, Macintosh owners could see italics and bold onscreen, but to print the screen as they saw it required a postscript printer, and such printers cost about $1,000 more than ordinary laser printers. The graphical user interface allowed users to learn programs much more easily, but in many business settings, a computer tended to be used for only a single application. In that environment, the operator had very little interaction with the operating system interface, and once the operator had learned the application, the advantages of the graphical user interface were diminished.

The case for DOS, therefore, was stronger than appears from the vantage of the 1990s with our multimegabyte memories and multigigabyte hard drives. Now that we routinely use computers that can run 30 times as fast as those old DOS machines and have 50 times the memory and 100 times the hard drive capacity, the requirements of a graphical operating system seem rather puny. They were enormous, however, in the days of DOS.

As processors became faster, memory cheaper, and hard drives larger, the advantages of a graphical user interface should have overcome any command-based, or text-based, system such as DOS. If we were still using DOS, that would certainly be an example of being stuck with an inferior product. We are not using DOS, however.

Instead we are using a Mac-like graphical user interface. If someone went to sleep in 1983 and awoke in 1995 to see a modern PC, he most likely would think that the Macintosh graphical user interface had been colorized and updated, with a second button added to the mouse.[20] Our modern Rip Van Winkle might be surprised to learn, however, that the owner of the graphical user interface was not Apple but Microsoft.

The movement from DOS to Windows was costly, yet it occurred quite rapidly. As in the other examples, what the evidence shows is quite the opposite of what the path-dependence pundits predict: not markets getting stuck in ruts, but markets that make changes when there is a clear advantage in doing so.

Microsoft's Dispute with the Justice Department

Historically, new antitrust doctrines have developed in connection with big cases, which most often involved the biggest and most successful companies. That pattern is being repeated today. Various antitrust actions against Microsoft have been the main venue for discussions and actions that propose and explore new economic foundations for antitrust and new interpretations of old antitrust doctrines.

Microsoft's antitrust problems began with a government investigation of its pricing of software sold to original equipment manufacturers (OEMs). Microsoft agreed to end those practices in a highly publicized 1994 consent decree with the Department of Justice. Whether or not those practices were anticompetitive, they doubtless had little to do with Microsoft's successes in the market.[21]

The consent decree did little, however, to end Microsoft's legal problems with the DOJ. When Microsoft attempted to purchase Intuit, a maker of financial software, the DOJ opposed the deal. In a highly publicized decision, the consent decree itself was temporarily overturned by Judge Stanley Sporkin's (later overturned) decision, which appears to be the first instance of path-dependence theory's having a serious influence on policy.

There were other skirmishes as well. The DOJ examined Microsoft's inclusion of the Microsoft Network icon on the Windows 95 desktop. It claimed that consumers would be unwittingly forced into acceptance of that product to the detriment of competition in the online service industry.

Most recently, the DOJ has accused Microsoft of attempting to divide the browser market with Netscape and, when Netscape refused its offer, of employing a variety of exclusionary tactics to unlawfully drive Netscape out of business.[22] In large part, the DOJ's claims revolve around Microsoft's inclusion of its Web browser in the Windows operating system[23] and Microsoft's insistence that OEMs not tamper with consumers' access to its browser.[24] The next section discusses those issues.

The DOJ's most recent lawsuit against Microsoft bears the clear imprint of path-dependence theory. The complaint argues that Microsoft's allegedly anti-competitive agreements "threaten to 'tip' the market permanently to Internet Explorer"[25] and that "because of the market's network effects, the significant increase in Microsoft's share of the browser market . . . will tip the market in Microsoft's favor and accelerate its dominance and competition's demise."[26] Ultimately, the DOJ regards network effects as problematic whether or not it can relate them to traditional antitrust violations: "[B]arriers that exist to the entry of new competitors or the expansion of smaller existing competitors, including network effects, mean that dominance once achieved cannot readily be reversed."[27]

A consortium of 21 attorneys general from various states and the District of Columbia joined the DOJ both in suing Microsoft and in embracing path-dependence theory. "Microsoft's operating system software enjoyed greater consumer acceptance, familiarity, and loyalty than its later competitors by virtue of the fact that it was first in the marketplace,"[28] their complaint argued, denying Microsoft any credit for offering quality goods at low prices. The attorneys general had a more trendy explanation of Microsoft's success: "Through 'network effects,' Microsoft was able to build upon this initial advantage."[29]

Newspaper accounts and public statements by other participants confirm that path-dependence theory has, in whole or in part, driven the DOJ's antitrust attack on Microsoft. The most famous, and perhaps most influential, attempt to connect these theories to antitrust is a study prepared by Gary Reback, a lawyer working for several of Microsoft's competitors, with the assistance of two econo-

mists who have played prominent roles in promoting path-dependence theory, Brian Arthur and Garth Saloner.[30]

Their "White Paper" on Microsoft goes far beyond the economics literature. They do not stop with the traditional path-dependence claim that a market-based economy is likely to choose all sorts of wrong products. Nor do they stop with the claim that innovation might be eliminated in the computing industry. Reback, Arthur, and Saloner instead portray Microsoft as an evil empire intent on nothing less than world domination. To hear them tell it, the American way of life will be imperiled if the government does not rein in Microsoft: "It is difficult to imagine that in an open society such as this one with multiple information sources, a single company could seize sufficient control of information transmission so as to constitute a threat to the underpinnings of a free society. But such a scenario is a realistic (and perhaps probable) outcome."[31]

Those are fantastic claims, indeed, and they were repeated at a recent conference on Microsoft, held by Ralph Nader, at which Reback, Arthur, and Saloner made presentations.[32] To judge from the DOJ's recent claims against Microsoft, all the talk about path dependence has begun to influence public policy. As the next section explains, however, path-dependence theory provides no justification for expanding antitrust enforcement.

Antitrust Doctrines and Network Technologies

Both the DOJ and some of Microsoft's private competitors have used theories of lock-in to support a call for heightened antitrust scrutiny of Microsoft. By itself, lock-in would seem not to constitute an antitrust offense. There is nothing in the law that makes it a crime to have technologies that are less than the best available or less than the best imaginable.[33] Instead, lock-in theories offer an alternative way to claim harm in the absence of the usual monopoly problem of elevated prices and restricted outputs. Lock-in stories also offer new life to and a contemporary spin on old antitrust doctrines. The following two subsections consider some of the antitrust issues that have been raised in the context of the software industry. The first subsection describes why monopoly leverage in theory requires special conditions that virtually guarantee it will not occur in practice. The second describes why no smart monopolist would try predatory bundling.

Monopoly Leverage, Tie-Ins, and Bundling

In theory, monopoly leverage occurs when a firm uses its monopoly in one industry to win a monopoly in another industry. Tie-in sales and bundling are contractual practices that are sometimes alleged to facilitate monopoly leverage, but tie-ins and bundling do not have to create a new monopoly to be profitable. Nor do tie-ins necessarily harm consumers.[34] In fact, as this subsection explains, the theory of monopoly leverage requires so many special conditions that monopoly leverage seems certain to remain a theoretical problem.

Economists have long been skeptical that monopoly leverage is either feasible or profitable. In most circumstances, forcing consumers to purchase some other product so as to create a second monopoly will not add to a firm's profits. A monopolist can instead simply extract the value of its monopoly through the pricing of the good in the market where it has its first monopoly.

Suppose, for example, that a firm held a monopoly on oil furnaces. Such a monopoly might be quite profitable; oil furnaces are useful and offer some advantages over other kinds of furnaces. The monopolist's ability to maximize profits would face some limits, of course, such as the availability of substitutes like propane and electric heating.[35] Still, the monopolist could devise a pricing system that captured the extra value of using an oil furnace rather than a competing source of heat. The lower the price of heating oil relative to the price of propane or electricity, the greater that value would be. If the furnace monopolist were to become the oil monopolist too, he might raise the price of heating oil, but that would only reduce what he could extract through the furnace price.

Consider this analogy: regardless of whether it worried you that someone had a key to the front door of your house, it would not worry you more if that person also had a key to your back door. Nevertheless, the idea that the second monopoly could be used for something has intuitive appeal. Even if the monopoly in furnaces could be used to extract everything that can be extracted from the furnace users, could not a monopoly in heating oil be used to extract something from people who use heating oil for another purpose? It turns out that, yes, there is a circumstance in which a second monopoly is worth something. That circumstance is a very limited one, however. If the

furnace monopolist could also monopolize the heating oil industry, he could extract additional monopoly rents from heating oil users who were not also his furnace customers.

The question then arises of whether one monopoly could ever be extended to capture customers of another market. The answer again is yes, it is possible--but, again, only under very special circumstances. If there were economies of scale in the heating oil industry and if too few customers bought heating oil for nonfurnace uses to support a separate supply of heating oil, then the furnace seller could lever his monopoly in furnaces into a monopoly in heating oil by preventing furnace customers from buying heating oil from other sources. By assumption, the nonfurnace customers would not offer a large enough market to support any independent oil supplier and the furnace monopolist could then extract new monopoly rents in that other market. That explanation of leverage is sometimes referred to as market foreclosure.[36] Ironically, the larger the furnace monopolist relative to the heating oil industry, the less likely it will benefit from monopolizing heating oil since it will already have virtually all the potential customers.[37]

That explanation shows that there is a theoretical possibility of harmful monopoly leverage but that it requires very special conditions. The leveraged market must be big enough to matter, but not so big as to allow competitive independent suppliers to survive. There must be some economies of scale in the leveraged market, but not enough to have caused prior monopolization of the market. The leveraged market must have many of the same customers as the initial monopoly, so as to provide control of the new market, but not too many, or there will be no new rents to extract by establishing the second monopoly. In short, leveraging can be viewed as the Goldilocks theory of monopoly extension--everything has to be just the right size.

Do the facts of the Microsoft case fit within the leverage story at all? If Microsoft requires each customer to buy one copy of some other Microsoft product, that, in and of itself, adds nothing to its profits. That sort of tie-in sale with fixed proportions has long been understood to offer no particular advantage to the monopolist.[38] So the issue becomes whether Microsoft could crowd out any rivals that sell to customers who do not use Microsoft's own operating system.

Here the application to Microsoft of the market foreclosure theory runs into trouble. If the products

allegedly crowded out by Microsoft's bundling are products that run only under the Windows operating system, then monopoly leverage offers Microsoft no advantage.

To illustrate that point, consider a hypothetical example of successful tying-foreclosure using personal software products, such as Quicken and Microsoft Money. Both are sold in both the Macintosh market and the Windows market. If Microsoft were to build Microsoft Money into the Windows operating system, and if that eliminated Quicken in the Windows market, and if the Macintosh market were too small to allow a product like Quicken to be produced at reasonable average cost for that market alone, and if Microsoft continued to sell the product separately in the Macintosh market (now at a monopoly price), and if there were few additional costs for Microsoft in creating a Macintosh version, then, and only then, would Microsoft benefit from leveraging monopoly.

Has that occurred? Does Microsoft sell in the Macintosh market disk compression, backup, fax software, or any other program that is included in the Windows operating system? The only product that comes to mind is a Macintosh version of Internet Explorer. But Microsoft gives away that product in the Macintosh market and promises a permanent price of zero. If Microsoft sticks to its promise, it cannot profit from including the browser in the operating system. Even then, the other required conditions for market foreclosure (that the Macintosh market be too small to support Navigator and the costs of Microsoft's creating a Macintosh version not be too large) probably would not be satisfied.

A simple rule that would prevent that type of foreclosure would be to prevent Microsoft from including in its operating system any program that it sells separately in another market. But to bar Microsoft from selling separate versions in other markets would exclude customers in those markets from the benefits of those programs, even when Microsoft did not contemplate market leverage. Given all the special conditions required for successful leveraging, it would be unwise to implement such a rule without further investigation of the potential harm of denying Microsoft products to consumers in tied markets. It bears repeating, moreover, that intervention would remain unjustified absent a showing that Microsoft has a sustainable monopoly in PC operating systems and that the costs of intervention, including its stifling effect on innovation, outweigh its putative benefits.

Predatory Bundling

The most recent allegations against Microsoft concern predatory use of its ownership of the Windows operating system. The specific allegation is that Microsoft's integration of its browser into the operating system is largely predatory in intent, aimed at forcing other firms out of the browser market. The implications of that issue, however, reach well beyond the browser market and extend to the very issues of what an operating system can be and the nature of progress in the software industry.

Antitrust law defines as predatory actions that are inconsistent with profit-maximizing behavior except when they succeed in driving a competitor out of business. In predatory pricing, for example, a would-be monopolist allegedly charges a price that is so low that other firms cannot sell their outputs at prices that will cover even their variable costs. The other firms are then forced either into bankruptcy or to exit the industry because they have become unprofitable. Upon completing the predatory phase, the predator then enjoys the benefits of monopoly pricing. Note that during the predatory phase consumers benefit greatly from the low prices; only the later monopoly pricing harms consumers.

Economists are generally skeptical of claims that price cuts or other actions have predatory intent because they have determined, both in theory and in practice, that predatory campaigns are unlikely to have profitable endings. First, the predatory action is likely to be more expensive for the predator than for the prey. The predator cannot just cut price; it must also meet market demand at the lower price. Otherwise, customers will be forced to patronize the prey, even if at higher prices. If the predator is a large firm, it stands to lose money at a faster rate than the prey. Second, even if the predation succeeds in bankrupting the prey, there is no guarantee that a reestablished firm will not just reenter the industry once the predator has established monopoly pricing. If there are fixed investments in the industry, such as durable specialized equipment, the predator cannot establish monopoly prices as long as the durable assets can return to the market. If there are no durable assets, then the prey can cheaply exit the industry and reenter when monopoly prices return. Either way, predation drains the predator while imposing uncertain burdens on the prey.

Another problem with predation is that almost any action that a firm takes to become more attractive to consumers can be alleged to be predatory. If customers like

something a firm is doing, its competitors will not. In the most elementary case, a price cut or product improvement will damage the prospects for some competitor. It bears noting that most of the alleged cases of predation have been demonstrated to be false.[39]

Predatory bundling, like predatory pricing, is a simple idea that ultimately proves too simple. If a firm with a controlling share of one product bundles in some other product, competitors who sell the bundled-in product will have to compete with a product that, to the consumer, has a zero cost. If Microsoft includes in its operating system a piece of software that competes with other vendors in what had been a separate market, Microsoft ensures that virtually all purchasers of computers then have a copy of the new software.

Suppose Microsoft bundles a fax program into Windows98. If Microsoft's fax program, relative to its cost, is better than other fax products, then the bundling is not predatory. The Microsoft product would win in the marketplace anyway; adding it to the operating system costs less than its value to consumers. If the product is worth more to consumers than the costs of creating it, then bundling will also be profitable without any exclusionary consequences. In contrast, if Microsoft's fax program, again considering its cost, is inferior to alternatives or provides less value than its cost, then Microsoft would profit only if bundling caused other firms to exit the market and if Microsoft were able to raise the operating system's price by the now-higher implicit monopoly price of its fax product.

As a strategy, however, predatory bundling has the same liabilities as predatory pricing. As in predatory pricing, Microsoft stands to lose money (relative to not including the fax software) faster than its rivals do if its fax program costs more to produce than its value to consumers. Moreover, a rival with a superior fax program could keep the product on the market at a price that reflects the advantages that it offers over the bundled product. The rival could not charge more than that because the Windows consumer would already have the inferior fax program. The rival could still capture the extra value that its own intellectual property contributes, however, especially since it would enjoy low marginal costs of "producing" (i.e., copying) its software and the marketing edge of an installed customer base. While it may lose profits or market share, therefore, the rival will retire its fax program only if it is inferior to Microsoft's.

From a social or consumer welfare perspective, then, Microsoft's bundling action would do no harm. The rival software is a fixed asset in the industry; it does not wear out. In the extreme case, a bankrupt producer might put its fax program on the Web, making it freely available to all. That would limit what consumers would be willing to pay for the program bundled into Windows98 to its extra value, which is zero. Thus Microsoft would be unable to charge a higher price for the bundled software despite having incurred the costs of creating the fax program. Microsoft would lose money and fail to monopolize the market. Furthermore, the talents that created the rival fax program still exist, ready for some other firm to hire should Microsoft ever achieve a monopoly price on the fax program.

Of course, an antitrust enforcer might reply that the operating system producer has distribution or coordination advantages that an independent rival lacks. If those advantages outweigh any quality advantages of the rival, however, it is efficient for the operating system producer to bundle its fax program.

That suggests that bundling, as a predatory action, is unlikely to succeed. Furthermore, the software industry has very important nonpredatory reasons to bundle functions into operating systems and other software products. As explained below, new sales of software will require continual additions to functionality.

In the Netscape case, antitrust enforcers might allege that Microsoft is not interested in defeating the Netscape browser as much as in destroying Netscape as a company. Industry pundits have often theorized that Web browsers might constitute a means of establishing a new operating system. Netscape, they allege, constitutes a threat to Microsoft's position in the operating system market. Regardless of the technical reasonableness of that claim, however, it runs into the same problems as other allegations of predation.

Here, as elsewhere, predation would not destroy the durable assets of the prey. Netscape's software will hardly disappear if Microsoft bundles a browser into Windows. Indeed, Netscape has already made the source code for its Navigator program publicly available. Even if Microsoft still tried to destroy Netscape in order to protect Windows' market share, it would ultimately fail. Any of Microsoft's several large and vigorous competitors, such as IBM or Sun, would happily purchase Netscape, or

hire its engineers, if they thought that by doing so they could share some of Microsoft's enviable profits.

The Rate of Innovation

Putative Dangers

One concern that has been raised by the Justice Department, in the Judiciary Committee hearings, by some journalists, and by several path-dependence theorists is that Microsoft's dominant position in the market will somehow inhibit innovation. The suggestion is that Microsoft will be able to so dominate the software market that no small firms will dare compete with it. Firms will be unwilling to create new products in any market that is likely to attract Microsoft's attention, especially in products that are possible additions to the operating system. It is not clear that current antitrust law addresses such concerns. If valid, however, and if not addressed by antitrust law, they might encourage new legislation. Of course, the impact of such legislation would probably reach beyond the computer industry.

Concerns about lock-in drive the accusations against Microsoft. Consumers are viewed as being so locked into Microsoft's products that, even if the Wintel platform fell far behind the cutting edge of computer technology, no other combination of an operating system, applications, and support could displace it. Obviously, no one can empirically disprove the claim that products might have been created that would have been better than currently existing products. Instead, the analysis here focuses on whether lock-in theory correctly concludes that Microsoft will stifle innovation in the computer industry.

Certainly there are instances in which Microsoft has incorporated programs into the operating system and the former providers of such programs have gone on to other things. Disk compression and memory management programs are two examples. Fax programs, backup programs, and disk-defragmenting programs are counterexamples: the inclusion of such programs in the operating system has not eliminated the separate market. The key factor appears to be whether the programs Microsoft includes in its operating system are as good as the separate programs or not. When Microsoft produces a product as good as or better than the competition, the separate market usually does disappear. It is difficult, however, to conceive of consumer harm in that case.

The general claim that innovation will suffer if Microsoft is allowed to grow and add programs to the operating system has several shortcomings. For one thing, it wrongly assumes that programmers hired by Microsoft lack or lose creativity. It proves nothing to observe that small startup companies generate creative ideas more frequently than Microsoft does. There are 15 times as many outside programmers developing programs for Windows as there are programmers working for Microsoft. That Microsoft does not lead the industry in creative programming thus hardly shows that Microsoft could not, or would not, hire programmers to produce software just as creative as that produced by smaller companies.

It is, of course, conceivable that large firms produce less innovation than small firms do (adjusting for size). That has been investigated at length in the economics literature with no clear consensus.[40] Every firm, no matter what its size, benefits from profitable new ideas. Microsoft itself recently announced plans to double its already huge research and development budget.[41]

The argument that large firms might not innovate as much as small firms usually relies on some variation of the view that large firms are fat and lazy; that is, that they do not innovate because they do not have to. Still, a dollar is a dollar. Most investors are just as eager for their large-firm stocks to maximize returns as they are for their small-firm stocks to do so. For the fat-and-lazy condition to hold, it must be that large firms with dispersed ownership of their stock do not have the same incentives to maximize shareholder value and profits as do small firms, which are usually closely held. That real possibility is known as the problem of separation of ownership and control.

With regard to Microsoft and many other successful high-technology firms, however, that argument would seem to have little force. The ownership of Microsoft and most other high-tech firms is not widely dispersed. For example, Bill Gates owns almost 25 percent of Microsoft and several other early Microsoft investors also own very substantial stakes. That may in fact explain why Microsoft is still considered such an intense competitor.

Alternatively, Microsoft's critics vaguely suggest that it stifles innovation because it copies software ideas from others, leaving the other firms no reward for their efforts. If that claim were true, the problem would appear to lie in intellectual property law, not Microsoft's purported monopoly power. After all, if

Microsoft were allowed to copy the ideas of its rivals, so would be a host of other large (or small) firms in the industry, in each instance lowering the profits of the innovator, large or small.[42]

It would be a serious problem if innovators in software were not being properly rewarded for their efforts. The purpose of intellectual property laws is to allow innovators to collect economic rewards for their efforts. Without such laws, imitators could free ride on the efforts of innovators and produce similar products at lower cost, driving true innovators out of business. So, while deserving of investigation, those problems do not seem to pertain to Microsoft, or its ownership of the operating system. Perhaps a reevaluation of intellectual property laws is in order. That claim seems to have little to do with antitrust.

Some factual matters do not seem consistent with the claim that Microsoft reduces innovation. Microsoft's behavior toward its developers, for example, does not seem to square with the claim that it is intent on driving out independent software producers. It launched a program last fall to "help out startups that are developing Microsoft-compatible software by giving them space in trade show booths, discounted software and passes to trade shows."[43] Unsurprisingly, some startups regard Microsoft warily and refuse its help. But "the companies that Microsoft invests in have few scare stories to report."[44]

More broadly, there seems to be little evidence that the pace of innovation is insufficiently rapid. The pace of innovation in the computer industry is generally regarded with some awe. Certainly, the Windows market does not appear to have suffered from stifled development of applications.[45]

Finally, there appear to be tremendous rewards to those who do innovate in this industry. Even the founders of Netscape, a supposed victim of Microsoft's power, walked away with hundreds of millions of dollars. Does that discourage others from taking the same path? Unless and until careful research answers those sorts of questions, any antitrust action would be premature and potentially dangerous to the software industry and economy.

A Real Danger to Innovation

The nature of software markets requires that software producers continually add functionality to their products.

In contrast, McDonald's can keep selling Big Macs because food is not durable and consumers want to purchase Big Macs that taste just like those they ate the day before. Because software lasts forever with no diminution in quality, however, consumers have no reason to repurchase a word processor or operating system unless an improved version comes to market. Undoubtedly, improving software will mean adding functionality.

Consider what it means to improve software. While software could be made faster, real speed improvements occur when consumers replace their old computers with faster ones. And while intuitive interfaces are useful, consumers can with practice become adept even with poorly designed software. Consumers will naturally tend to stick with a familiar version of a program (or operating system) unless a newer version performs some useful tasks not available in the old version. That requires adding functionality not found in previous versions.

Added functionality can be seen in every category of software. Newer word processors have far more functionality than earlier versions. Spell and grammar checkers, mail-merge programs, and thesauruses are among the many features now standard in virtually all word processors. Spreadsheets, database programs, and virtually every other category of program have far more functionality than before.[46] That is one reason why new software seems to fill our ever-expanding hard drives, which have hundreds or thousands of times the storage capacity of earlier machines.

The consumer benefits in many ways from added functionality. Large programs almost always cost far less than the sum of the prices that the individual component products used to command. The various components also tend to work together far better than separate components because they are made for each other. If that were not the case, consumers would not purchase new generations of software products.

As programs become more functional, the number of small companies specializing in add-ons may shrink. But that is no reason to prevent creators of word processors from including grammar checkers and thesauruses. Should the producers of dominant programs be forbidden to add functionality while producers of less successful programs are allowed to add new functions? That hardly seems a recipe for success. Do we really believe that innovation was retarded because add-on companies feared that they might be put out of business? Do we even know if they

have been put out of business, or that those programmers are no longer working on new ideas? Again, the weak logic and scant evidence supporting them make such claims suspect.

Yet some Microsoft critics, including those within the government, have proposed freezing the operating system, putting an end to new functionality. If that proposal were accepted for the operating system, it might logically apply to other categories of software. The results would be disastrous, for software producers, who would have no new sales except to new computer users, for computer manufacturers, who would find little demand for more capable hardware, and, most important, for users, who would be forced to use seriously crippled software. Few proposed antitrust policies are as dangerous as that one.

Who Should Get to Assign Desktop Icons? The Irrelevance of the "Browser Wars"

At the Senate hearings and in the media, considerable attention has been given to the claim that Microsoft's desire to prevent OEMs from removing the Internet Explorer icon from the desktop was somehow inimical to competition. This section explains why Microsoft and OEMs might each want to control the placement of desktop icons and provides an economic framework for deciding who should be allowed to control the desktop icons--if it really matters. Ultimately, icon placement should probably not matter even to the computer and software industry, much less to antitrust enforcers.

Control of the desktop might be valuable since, as a practical matter, all computer users see the desktop. In principle, desktop placements of "advertisements," whether programs or messages, could be sold to companies interested in such exposure. For example, assume that an icon for America Online appears on the desktop. Consumers interested in an online service might just click on the icon and begin the process of becoming an America Online customer. Knowing that, a company such as America Online might be willing to pay the controller of the desktop for a good placement of its icon.[47]

Assume, then, that icon placements are indeed valuable. The next subsection explains why, nonetheless, regulators should not care whether Microsoft or OEMs control icon placement. Following that, the discussion critically reexamines the assumption that control of icons should matter even to the computer industry.

A Simple Theory of "Desktop Rights"

If placing icons on the desktop can generate revenue, it should not be surprising that OEMs and the owner of the operating system (Microsoft) will both claim the right to place the icons. Economic analysis allows us to examine whether it makes any difference who has that right. It also may provide some guidance as to who should get it.

The Coase theorem helps to explain the tradeoffs involved.[48] If the rights to place desktop icons were well defined, and if there were no transactions costs or wealth effects,[49] the Coase theorem tells us that regardless of who initially had the rights, they would end up where they had the greatest value.

Consider the following example. If the rights to sell desktop placement were worth $5 to Microsoft and $10 to OEMs, then OEMs would wind up controlling the desktop icons regardless of who initially did so. If Microsoft initially controlled the desktop, OEMs would be willing to pay up to $10 to Microsoft for the rights, and Microsoft would be better off selling the rights to OEMs--perhaps by raising the price of the operating system by more than $5 but less than $10.

If, on the other hand, OEMs initially controlled desktop placements, Microsoft would be willing to lower the price of the operating system by up to $5 in exchange for the right to control icon placements. OEMs would prefer to keep the rights themselves, however, since they can generate more than $5 in revenues by maintaining control. In either case, OEMs wind up with the rights, and both parties share the $10 in extra revenue brought about by icon placement sales. Although the two parties might be expected to fight over the rights, it makes no difference to the rest of us who prevails. By analogy, as virtually all microeconomics textbooks explain, if the government subsidizes gasoline purchases, it makes no difference whether automobile drivers or service stations receive the subsidy, because in either case the subsidy is shared in exactly the same way.

Sometimes the assumptions of the Coase theorem are not met. For example, if negotiations between OEMs and Microsoft were not feasible, efficiency considerations would require that the property rights be assigned to the party who could generate the highest value for desktop placements.[50] Since Microsoft and OEMs are already negotiating over other aspects of the desktop (e.g., price),

however, there is little reason to believe that the market will not work efficiently.

The current anxiety regarding desktop placements is misplaced. As long as the parties freely enter into new contracts, neither party will benefit from a legal stipulation of who initially controls the desktop. It should not matter at all to the government who has the right.

The reader may naturally ask, "If it makes no difference, why is there fighting over who places the icons?" There are two answers. First, there is little evidence that Microsoft and OEMs are fighting. It is Microsoft's competitors who are complaining. Second, it is not unusual in such circumstances for there to be contract disputes or strategic behavior. Two parties can negotiate a contract, then subsequently dispute their understanding of the terms of that contract. If, for example, OEMs are receiving a lower price from Microsoft because Microsoft thought it controlled desktop placement, but now OEMs have a chance to sell icon placement while remaining under a fixed contractual price for Windows, it would not be surprising that a dispute would arise.

Is Icon Placement Valuable?

For icon placement to be valuable, it must generate future revenues. America Online benefits in the previous example because consumers could not use its services without paying a monthly fee. Having its icon on the desktop increased the chances that consumers would sign up for the service.

For a typical software product to be on the desktop, however, the software is usually already installed on the computer, and thus already purchased. The icon placement only increases its likelihood of use. The only additional benefits to the software producer from having the consumer use the software after purchasing it is that the consumer might purchase upgrades or ancillary products.

For the Netscape and Microsoft browsers there are several reasons why the icon placement might be important. (This analysis ignores any future revenues from upgrades since both companies have agreed not to charge for browsers or upgrades.) First, Netscape and Microsoft might be able to trade off the success of their browsers to sell software specializing in serving up Web pages (known as servers) because of their large presence among

the base of users and the (presumably) assured compatibility with these browsers.

Second, when a browser is first put into use, it goes to a default starting location on the Internet.[51] If many Web users (surfers) view a particular location, advertising revenues can be generated, as some popular locations on the Internet, such as Yahoo, have discovered. Yahoo, in fact, paid Netscape many millions of dollars to provide Netscape users an easy way to reach the Yahoo page. Netscape and Microsoft, although somewhat late to that game, are both working on new start pages (to which the browsers will be preprogrammed to go) in the hopes of enticing users to stay at their Web sites. By leading consumers to particular pages, browsers might become a potent revenue-generating force.

Some industry analysts are skeptical that browser icons provide valuable control of the start page, however. First, users can easily alter the start page. To cite a familiar example, a radio station would not pay automobile dealers to have car radios preset to its frequency. The radio station would not benefit from such a deal because car buyers can easily change the preset stations. Similarly, how can icon owners benefit when consumers find it easy to change the icons on the desktop? The parallel will become still more compelling as consumers become more accustomed to customizing their operating systems.

There is, however, a more fundamental impediment to the claim that desktop placement is important for browsers. Just having the icon on the desktop is insufficient to gain access to the Internet. Clicking on that icon will not connect users to the Internet. For that they will have to use one of many Internet service providers. The Internet service provider will almost certainly provide its own browser, independent of what icon is on the desktop.[52] Therefore, the icon on the desktop at the time of sale does not provide much value.

Finally, the concept of detailed governmental control over desktop placement leads to other endless and absurd questions. What about the Start button in Windows? The order of programs tends to be alphabetical. Should the government be concerned about the ordering of those programs, and who gets the rights to order them? Has anyone investigated whether the various color schemes found in Windows benefit Microsoft's icons over the alternatives? Does the Windows screen saver that animates a Microsoft

Windows icon have anti-competitive subliminal effects? In conclusion, and in all seriousness, we should ask, Should the government really be involved in those decisions?

Implications

The theories of path dependence and lock-in are relatively new to the economic literature. They have not won over the economics profession after years of debate; nor have they made their way into many economics textbooks. They do not draw on first principles in obvious and secure ways. That does not make theories of path dependence and lock-in bad economics, or wrong economics, or inappropriate topics for academic research. On the contrary, it makes the academic debate that much more important. Those theories, however, are a poor foundation for public policies that could affect the progressiveness of the American economy.

If we were treating a dying industry, even speculative economic medicine might be worth a try. But the computer and software industries continue to astound most people--both with the rates at which products improve and the pace at which prices decline. It makes no sense to submit such a robust patient to the risks of economic quackery.

In our academic writings, summarized above, we show that there is a poor connection between theories of path dependence and the real-world behaviors of entrepreneurs and consumers. Moreover, no connection exists between the alleged empirical support for those theories and real events. Contrary to the lock-in claim, and contrary to some popular stories of markets gone awry, good products do seem to displace bad ones. Since there is no real support for the supposition that markets fail in an environment of increasing returns to scale, there is no more basis for antitrust in high-tech markets than in any others.

There might even be less reason to apply antitrust to such markets. Our most basic theory of increasing returns implies that monopoly or near-monopoly equilibria are likely. Where people do value compatibility, or where increases in the scale of a firm really do lower its costs, dominant formats or single producers will probably result at particular moments.

Furthermore, consumers want it that way. Anything else will frustrate the urge for compatibility or unneces-

sarily raise costs, or both. Monopoly outcomes thus need not imply that anything has gone wrong or has been done wrong. Monopolies that are undone by the government may lead only to monopolies that are redone in the market. The faces may change, but market structure may not. If we insist that natural monopolies be populated by several firms kept at inefficiently small size, we are likely to find those markets taken over by foreign companies without such restrictions.

In such markets, firms compete to win a monopoly. Thanks to this competition, firms selling products that create more value for consumers prevail against those that create less. The somewhat paradoxical result: the very acts of competition that bring us superior standards--the strategies that save us from things like inadequate videotapes and expensive operating systems--will look like monopolizing acts. In some sense, after all, they are. Competitive strategies, when successful, award temporary monopolies. Eventually, however, better products prompt new campaigns to unseat existing monopolies in markets with increasing returns.

Many of the other claims that surround the new antitrust debate are disconnected, not only from real world observations, but also from any real theoretical support. One such claim is that Microsoft would like to crush any would-be direct competitor. It probably would. Theory and history, however, do not tell us how predation could ever work in a world in which assets are perfectly durable. Further, Microsoft has been demonstrably unsuccessful in crushing anything except where its products are better than those of the opposition. They had to resort to buying uncrushed Intuit; they have barely dented America Online with the much ballyhooed Microsoft Network; and they only began to erode Netscape's near monopoly when their own browser came up to snuff. Microsoft's products that dominate in the Windows environment are the very ones that have dominated elsewhere.[53]

There is, finally, the vaguely posed claim that Microsoft stifles innovation--another disconnect. The claim fails to conform to several prominent features of the PC landscape. First, Microsoft courts and supports its many software developers, who now number in the hundreds of thousands. Second, the personal computing industry, by any practical standard of comparison, is astonishingly innovative.

Finally and most important, antitrust doctrines brought to bear against Microsoft cannot be construed to

apply to Microsoft alone. If regulators can put a short leash on the biggest operating system, then why not also on the biggest producer of database software, which sets the standards for that activity, or the biggest producer of printers, or scanners, or modems, or microprocessors, and so on? If those new technologies do exhibit increasing returns, or important reliance on standards, or network effects, then we are likely to see high concentration in many of those areas. Unless regulators embark on a relentless attack on whatever succeeds most, they must acknowledge that firms in high-tech markets hurt competitors even as they benefit consumers.

Notes

1. Susan Garland, "Commentary: Justice vs. Microsoft: Why It Has a Case," Business Week, November 17, 1997, p. 147.

2. Alan Murray, "The Outlook: Antitrust Isn't Obsolete in an Era of High-Tech," Wall Street Journal, November 10, 1997, p. A1.

3. We are not, however, aware of any formal studies that examine market shares and prices in high-tech markets.

4. See W. Brian Arthur, "Competing Technologies, Increasing Returns, and Lock-In by Historical Events," Economic Journal 97 (1989): 642-65.

5. For a more complete discussion of this table, see S. J. Liebowitz and S. E. Margolis, "Path Dependence, Lock-in, and History," Journal of Law, Economics and Organization 11 (1995): 205-26.

6. Stochastic processes are characterized by random incremental change on a fine scale but probabilistically predictable change on a gross scale. For example, a single coin flip has a random outcome whereas a series of coin flips will tend toward an even distribution of heads and tails.

7. See S. J. Liebowitz and S. E. Margolis, "Should Technology Choice Be a Concern of Antitrust Policy?" Harvard Journal of Law and Technology 9 (1996): 283-318, for an example of a multiple equilibria model.

8. See, for example, Paul A. David, "Clio and the Economics of QWERTY," American Economic Review 75 (1985): 332-37; Joseph Farrell and Garth Saloner, "Standardization, Compatibility, and Innovation," RAND Journal of Economics

(1985): 70-83; and Michael L. Katz and Carl C. Shapiro, "Network Externalities, Competition, and Compatibility," American Economic Review 75 (1985): 424-40.

9. Paul R. Krugman, Peddling Prosperity: Economic Sense and Nonsense in the Age of Diminishing Expectations (New York: W.W. Norton, 1994).

10. Lee Gomes, "QWERTY Spells a Saga of Market Economics," Wall Street Journal, February 25, 1998, pp. B1 and B6.

11. For a full debunking of the QWERTY myth, see S. J. Liebowitz and S. E. Margolis, "Fable of the Keys," Journal of Law and Economics 33 (1990): 1-25.

12. Gomes reports that David, author of "Clio and the Economics of QWERTY," the paper that introduced economists to this story, never saw the Navy study. See Gomes, p. B6.

13. Liebowitz and Margolis, "Fable of the Keys."

14. "Appraising Microsoft and Its Global Strategy," Washington, November 13-14, 1997. RealAudio files of the conference are available at http://www.appraising-microsoft.org/day1rm.html.

15. For a fuller account of the facts summarized here, see Liebowitz and Margolis, "Path Dependence, Lock-in, and History," pp. 218-22. See also Liebowitz and Margolis, "Should Technology Choice Be a Concern of Antitrust Policy?" and S. J. Liebowitz and S. E. Margolis, "Network Externality: An Uncommon Tragedy," Journal of Economic Perspectives 8 (1994): 147-49.

16. W. Brian Arthur, "Positive Feedbacks in the Economy," Scientific American, February 1990, p. 92.

17. Pick up Newsweek in 1996 and there is Steve Wozniak, the engineering wunderkind largely responsible for Apple's early success, explaining that Apple's recent failures were just another example of a better product losing out to an inferior alternative. "Like the Dvorak keyboard, Apple's superior operating system lost the market-share war," he said. Steve Wozniak, "How We Failed Apple," Newsweek, February 19, 1996, p. 48.

18. For a fuller account of the facts summarized here, see Liebowitz and Margolis, "Should Technology Choice Be a Concern of Antitrust Policy?" pp. 316-17.

19. The screen display on the PC required only 5 or 10 percent of the computer memory that was required by the Macintosh screen.

20. The original graphical user interface, developed at the Xerox PARC research center, had three buttons. The Microsoft community takes great pride in its use of but a single button and often defends it as optimal.

21. See "Declaration of Kenneth J. Arrow," in Memorandum of the United States of America in Support of Motion to Enter Final Judgment and in Opposition to the Positions of IDE Corporation and Amici, January 17, 1995.

22. See Complaint, U.S. v. Microsoft Corp., No. __ (U.S. Dist. Ct., D.C. filed May 18, 1998), http://www.usdoj.gov/atr/cases3/micros/1763.htm.

23. Ibid. at 35-46, ¶¶ 103-23.

24. Ibid. at 31-34, ¶¶ 93-102.

25. Ibid. at 12, ¶ 35.

26. Ibid. at 46, ¶ 127.

27. Ibid. at 47, ¶ 128. See also Memorandum of the United States in Support of Motion for Preliminary Injunction, U.S. v. Microsoft Corp., No. __ (U.S. Dist. Ct., D.C. filed May 18, 1998), http://www.usdoj.gov/atr/cases3/micros/1762.htm, p. 11: "Microsoft's conduct threatens in economic terms irreversibly to 'tip' the market in its favor"; and ibid. at 17: "[N]etwork effects give Microsoft a tremendous advantage."

28. Complaint, New York, et al. v. Microsoft Corp., No. __ (U.S. Dist. Ct., D.C. filed May 18, 1998), http://www.oag.state.ny.us/press/may98/microsoft. html, ¶15.

29. Ibid. at ¶ 16. See also ibid. at ¶ 26: "Substantial barriers prevent entry and establishment in the PC operating system market. These include large 'sunk' costs, network effects, the 'lock-in' effect, and high switching costs."

30. Gary L. Reback, Brian Arthur, and Garth Saloner, "Microsoft White Paper: Technological, Economic and Legal Perspectives Regarding Microsoft's Business Strategy in Light of the Proposed Acquisition of Intuit, Inc.," February 1, 1995, http://www.upside.com/texis/mvm/story?id=34712c0e38. See also Revised Joint Brief of

Amici Curiae on Common Issues, U.S. v. Microsoft Corp., Nos. 95-5037, 95-5039 (U.S. Dist. Ct., D.C. filed April 6, 1995), http://wsgrgate.wsgr.com/Resources/IntProp/Briefs/ms_brief.pdf (citing works of Arthur and Saloner).

31. Reback, Arthur, and Soloner.

32. See RealAudio files of Nader's conference, held in Washington, November 13-14, 1997, "Appraising Microsoft and Its Global Strategy," http://www. appraising-microsoft .org/day1rm.html.

33. That is not to say, however, that antitrust laws as written are ideal. If there really were serious problems with lock-ins to inferior technology, we might want to rewrite the antitrust laws. (Even then, serious questions about whether antitrust violates rights to property and free exchange would remain unanswered.) For the reasons set forth here, however, there is no evidence that lock-in presents a serious problem.

34. Tie-in sales may allow the monopolist to capture more of the surplus created by the monopolized good, may spread risk, may contribute to quality control, or may provide a cheap means for monitoring intellectual property infringement. Such effects of tie-ins do not require monopolization of a second market. Furthermore, where tie-ins are profitable for any of these reasons, they may contribute to economic efficiency. See S. J. Liebowitz, "Tie-in Sales, Risk Reduction and Price Discrimination," Economic Inquiry 21 (1983): 387-99. Bundling is very common for all kinds of goods. People buy season tickets, cars with tires and transmissions, and houses with microwave ovens and furnaces. Bundling can be explained by efficiencies of either production or purchase and commonly occurs in highly competitive markets.

35. That analysis ignores natural gas, which in fact is usually cheaper than oil where it can be had.

36. While that explanation has been around in antitrust economics for some time, it is formalized in Michael Whinston, "Tying, Foreclosure and Exclusion," American Economic Review 80 (1990): 837-59.

37. Furthermore, the existence of economies of scale in heating oil makes it likely that someone else has already monopolized the industry, in which case extending the monopoly from furnaces to oil would cause no economic harm; it would merely change the identity of the monopolist. The furnace monopolist is likely to benefit if it

can avoid dealing with an oil monopolist who can share in the furnace monopolist's profits, or lead to lower joint profits if the two monopolists each try to take larger shares of the profit.

38. That does not hold true if a different firm monopolizes the tied market, as discussed in the previous note. However, consumers suffer no harm at all if Microsoft replaces the other monopolist; thus there is no reason that antitrust should care about that outcome.

39. The most famous case is John D. Rockefeller's Standard Oil. John McGee, however, demonstrates that there were virtually no instances of predatory pricing by Rockefeller. See John McGee, "Predatory Price Cutting: The Standard Oil (N.J.) Case," Journal of Law and Economics 1 (1958): 137-69.

40. See F. M. Scherer, Industrial Market Structure and Economic Performance, 2d ed. (Chicago: Rand McNally, 1980), p. 418: "One conclusion relevant to public policy follows immediately. No single firm size is uniquely conducive to technological progress. There is room for firms of all sizes." See also William Shughart, The Organization of Industry (Homewood, Ill.: Richard D. Irwin, 1990), p. 356: "Industrial creativity does seem to depend on something other than pure size."

41. "Microsoft now boasts one of the corporate world's biggest annual research and development budgets at $2.6 billion. . . . almost a quarter of its 1996-97 sales revenue." Gates nonetheless recently announced plans to double Microsoft's R&D budget. Reuters, "Gates Expects Microsoft's Research Budget to Double," Minneapolis Star Tribune, March 18, 1998, p. 5D.

42. Note that many small start-ups have in fact gained access to enormous amounts of capital in the equities market when they have been able to convince investors of the potential value of their ideas. Those would include Netscape, Yahoo, and many other Internet companies.

43. Julia Angwin, "Stealth Financiers; Microsoft's Ventures; Company Has $3 Billion in Startups," San Francisco Chronicle, November 13, 1997, p. B1.

44. Ibid.

45. Surely no one would want to argue that the software market has been insufficiently innovative in recent years.

Nonetheless, it remains very difficult to prove that the industry has been optimally innovative.

46. For example, word processors now contain draw packages, paint packages, graphing packages, dictionaries, thesauruses, grammar checkers, equation editors, outliners, and so forth. Spreadsheets now routinely include spell checkers, graphics packages, statistics programs, financial programs, programming languages, linear and nonlinear programming routines, and so forth. Even fax programs now contain optical character recognition software (to convert faxes to text), draw packages to create cover pages, and so forth.

47. That was supposedly the main ingredient in a well-publicized deal whereby America Online agreed to include Internet Explorer on its installation disks (although users could use Netscape's browser if they so wished). See Julie Pitta, "The Cutting Edge; Showdown on the Web; Microsoft, Netscape Battle for Net Dominance," Los Angeles Times, July 8, 1996, p. D1.

48. See Ronald Coase, "The Problem of Social Cost," Journal of Law and Economics 3 (1960): 1-44.

49. "Transactions costs" include such things as the costs of finding parties willing to conduct business, the costs of negotiating deals, and the costs of arranging for payment and delivery. "Wealth effects" refers to the fact that parties enriched by an initial entitlement to a good might skew final outcomes in a market because they will consume in accord with their peculiar preferences. Whoever has the initial entitlement to a glass of water in a desert will, for example, probably end up drinking it.

50. Who is most likely to maximize the value of desktop placement? The ability to generate value in desktop placement depends largely on the costs of searching, marketing, and negotiating desktop placement with both users and placement purchasers. In that case, it might appear that Microsoft would be able to transact at lower costs with placement purchasers than could OEMs, arguing for giving Microsoft the property rights. First, OEMs are not included in the upgrade market, and thus Microsoft already would be negotiating for the desktop placements. The additional costs for Microsoft's controlling OEM placements would seem trivial. Second, each OEM would likely duplicate the marketing, search, and negotiation costs of other OEMs. On the other hand, OEMs often sell other software to customers of whom Microsoft has no knowledge. Although the placement of the icons could be preordered in a par-

ticular way, that might impose its own inefficiencies and could conceivably tilt the result toward giving OEMs property rights. The bottom line is that at this time it remains unclear who can maximize desktop value.

51. Early in the history of the Internet, it was possible to have a browser and not know what to do to get started. Start pages cropped up to help consumers learn to maneuver their way around the Web.

52. For example, both America Online and AT&T's Worldcom Internet services use a version of Internet Explorer that is specially set up to go to America OnLine's and AT&T's homepage, respectively. Note that control of the start page is a Coasian problem analogous to the icon placement problem.

53. The market share for Microsoft applications (such as Word and Excel) in the Macintosh market, for example, has historically been far larger than in the Windows market.

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