Network Effects and Microsoft

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Abstract

Economic theories of network effects have a number of testable implications. Testing of the theory by econometric methods, however, has proved difficult. I turn to documentary methods in order to test the theory, drawing on the body of documents used as evidence in *U.S. vs. Microsoft.* Analysis strikingly similar to the theory, including not only the main implications but also key analytical distinctions, guides business decision making. The same analysis suggests several interesting areas in which the theory is incomplete. Document based research raises a number of novel methodological issues.

1) Introduction

The economic theory of network effects has received a great deal of sustained attention, as it appears to capture some of the most important features of modern high tech industries.[1] The positive implications of the theory are important for understanding the structure of those industries, especially over time. They include positive feedback in the decision rules of individual actors, indeterminacy of equilibrium, lock-in to particular network standards, first-mover advantages or barriers to entry, high inertia for established standards but high volatility for nascent ones, and strategic competition that is intense in the period of establishing a network standard, then largely absent after lock-in.

This is not the simplest body of implications to test, for two reasons. As the theory involves strong elements of positive feedback and the resulting coordination, econometric testing faces severe difficulties associated with distinguishing the behavior of different actors.[2] Another critical implication of the theory, multiple equilibria and the resulting indeterminacy, poses very difficult problems for the empirical scholar of attempting to observe what didn't happen.[3]

This paper tests the theory by looking at business documents from the Microsoft antitrust case. While the documents are public because attorneys thought they would be useful in the policy context of a trial, my use is entirely positive, not normative. The unique perspective offered by internal documents gives us an opportunity to examine the relationship between the theory and the marketplace in several ways. Microsoft is a very analytical firm, and thinks of itself as involved in complex strategic games involving many outside agents. This means, first, that there is a great deal of internal discussion of the theory of behavior of other agents in the marketplace, including customers, competitors (where they exist) and complementors.[4] Further, many of the documents take as their focus the industry, not the firm, and many of them are quite explicitly theoretical (if not in a formal, abstract way.) These foci of the documents arise because Microsoft in part because thinks of itself as a leader relative to other participants in the industry, and thus seeks to understand their reaction function, and in part because, when there is competition, it seeks to understand the dynamic game well enough to take a leadership position in it. The firm's internal theory documented here is visible because it is used to guide strategic decision-making, and to delegate action by explaining the strategic goals. Finally, Microsoft views itself as in the business of guiding and leading positive feedback, and is often careful to explain its strategies to suppliers of complements in terms of industry equilibrium.

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[1] Surveyed in David and Greenstein (1990), Besen and Farrell (1994), Katz and Shapiro (1994).

[2] A literature looks at the (hedonic) price premium for standard products (Brynjolfsson and Kemerer (1996), Gandal (1994)) in an approach which cannot easily distinguish quality from lock in. Greenstein (1997) looks at individual customer lock-in by looking at persistence in brand choices.

[3] A substantial literature looks at the related welfare economic implications, attempting to show that either the equilibrium chosen by the market is inferior to its alternative (e.g., David (1985)) or that the market equilibrium is superior to the unchosen alternative (e.g., Liebowitz and Margolis (1999)). As one of the two compared outcomes never happened, this is a difficult if not impossible approach. Saloner and Shepard (1995) and Gowrisankaran and Stavins (2000) escape the problem by looking at the same—geographically local—network effects in many markets, a strategy that won't work for worldwide standards.

[4] In a few instances I examine the other firms' documents to confirm Microsoft's view.

The sections that focus on the relevant economic theory and its presence in the documents (sections 2)--5) of this paper) show high predictive value of economic theory. Most of the positive elements of the more formal theory are clearly present in the documents: positive feedback, lock-in, first mover advantages, installed base effects, high inertia in established networks but low inertia in new ones, indeterminacy of equilibrium, and the importance of strategic choices about compatibility and incompatibility. Indeed, as we shall see in Section 5), even the *limitations* on the logic of "mainstream" network effects theory that have concerned economists have been carefully considered by Microsoft executives.

The theory falls short of fully capturing Microsoft's view of the issues on some trivial dimensions and two very important ones, as we shall see in section 6). Trivially, life is far more complex than abstract theory, and in the world (a) there is a great deal of managing and mess wrapped around the abstractions of equilibrium and (b) no industry situation ever corresponds cleanly to a single model. More interestingly, Microsoft clearly forms its theory by inductive methods rather than our deductive ones, and this has taken them to some interesting ideas where economic theory has not yet gone. Microsoft, as the proprietor of a locked-in *de facto* standard, Windows, is intensely interested in the circumstances by which lock in can end. This is a stepchild in the formal theory, and the firm's analysis of it shows that we have missed an important way in which partial equilibrium and general equilibrium diverge. A firm controlling a locked in standard can face new competition by means of disruptive technical or market change in complementary technologies. This opens up several areas in which Microsoft's inductive method have taken them to interesting observations.

2) Standards Theory

Network effects and compatibility standards have a rich body of theory.[5] In many markets, there is a return to coordination on a particular standard in order to achieve network effects. The network effects may be "direct," as when users of word processing software who want to share files are better off using programs that store files in the same, standard, way. The network effects may be realized only through a "proprietary" standard, as when each brand of word processing software stores files its own way, so users sharing files must buy the same brand. Or the standard may be "open," as when any word processing program can read the files of any other. In either case, users may wish to choose products embodying the same standard as other users choose in order to gain the network effects, potentially ignoring their own preferences for the product.

Network effects also can arise when individual products are not very valuable if used alone, but become valuable when combined with complements into systems. Users may buy a computer in order to run complementary applications, or get a browser and connect to the World Wide Web in order to see complementary web pages. In these circumstances, there can be are "indirect" network effects. If suppliers of complements (applications software authors or web content developers in the examples) have increasing returns to scale, they will have an economic incentive to supply complements compatible with the system with the largest body of users. If the incremental costs of also supplying for a second system have a fixed component ("porting costs" in the

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[5] Surveyed in papers cited in note 1.

language of software) then there will be an incentive to supply first or only to the largest system. If users value the number or variety of complements, an "indirect" network effect among users arises as they might want to choose the same system as others.

With either direct or indirect network effects expectations can matter. A user who anticipates using a system over a period of time will care about the future choices of others, for they determine the future flow of network effects. A developer's or complement supplier's expectations about future usage of a system will affect current supply decisions.

This simple structure been embedded in models in which the strategies of users, systems suppliers, and complement suppliers are all explicit. Most treatments assume that the users and complement supplies are nonstrategic actors, and that these classes of actors cannot easily contract among themselves. Each chooses individually, depending on individual tastes and expectations. Suppliers of systems, however, are often treated as strategic actors who might attempt to move the equilibrium of the whole market in their favor. These assumptions lead to a rich list of implications; considering whether to relax key assumptions leads to a precise statement of the limitations of those implications.

a) *Implications looking only at users and developers*

Looking at the economic incentives of users and developers in this framework leads to the implication that there are likely to be only a few or even one standards because of positive feedback. In the direct network effects case, this follows from the matching behavior of users. In the indirect network effects case, it arises because users are drawn to the system favored by developers, and vice versa. These are "installed base effects" in the language of some of the theory, "positive feedback" in a related language. This will lead to one standard if there is not much variety in tastes for standards, or to few standards if taste variety leads some users and developers to standardize on a minority system.

There is a fundamental indeterminacy at this, static, level of analysis. The network effects tell us there will be few standards, but not which ones. In the simplest case of direct network effects with no variety in tastes, all users could use one product or the other. Similarly, all users and developers could use one system. If we look only at the (static) Nash game among users, or users and developers, it is indeterminate. Indeed, one equilibrium can be the inferior of the two standards, as parts of the literature have emphasized.

One way to resolve the indeterminacy is to play the game among users and developers sequentially over time, assuming that choices are irreversible, so that the choices of the early ones condition the choices of the later ones. In the perfect-information case, this will lead to determinacy (other than in the knife-edge case). More generally, the literature examines models with uncertainty (about the system or about future adopters' preferences) in the early going, and with system-specific sunk costs by individual users and developers or coordination costs of changing systems together. Then early choices will tend to persist, even if later information arrives that might lead to reversals. The system tends to converge to a single standard, but not necessarily the *ex post* pareto-superior one. It is also the case that expectations matter. If early choosers anticipate that later events will lead to a particular standard, they may follow that lead.

The theory has, in the case where uncertainty is treated, concentrated on dynamic models in which there is a period of uncertainty and then choices "tip" to one standard or the other. The language that is used in the theory varies, with "lock in" or "tipping" often used to describe a single transition from a <u>first phase</u> in which the dynamic equilibrium has not yet chosen a standard to a <u>second phase</u> in which it irreversibly has. More generally, the models exhibit a first phase characterized volatility or momentum followed by a second phase with inertia.

b) Implications for systems providers

When users and developers sink system-specific investments, the network effects are dynamic, offering a role for expectations, for strategy, and for inertia. When strategic actors sponsor system-defining technologies, this situation leads to a very rich set of theoretical issues, especially when multiple strategic actors contend for the same leading position. One result stands out among these. Sellers of systems that might be the beneficiaries of positive feedback should have high willingness to pay to have their standard adopted. With early malleability and later lock in, competition should be more intense in the early going and then there should be a period of far less competition as the winner of the "standards race" enjoys a period of locked-in monopoly.

While the literature has emphasized this pattern in connection with price competition, much the same points apply to quality competition. On the user side, systems products can offer better quality features that they deliver directly, such as a better user interface. To encourage complementary supply,[6] systems providers may offer a higher quality development environment, for example, superior Applications Programming Interfaces ("APIs").

The positive feedback loop arises because developers choose a standard not only for its native technological qualities as a development environment, but also for the extent to which it is used, while users choose products that embody the standard not only for their standalone qualities but also for the degree to which developers enhance it.

c) Limits of these results and key analytical distinctions

The framework just laid out is one in which a variety of related models lead to similar implications. The broader literature has surfaced two very different sets of reasons to worry about these implications. One set of reasons might be called "price theoretic" and asks why, if an implication is that the market goes to a pareto-inferior outcome, some contractual, institutional or entrepreneurial mechanism does not arise to prevent this. Obviously, the assumption of costly contracting among the follower actors is potentially important. The same perspective, involving this time the possibility of contracting (explicitly or implicitly) among follower actors and systems sellers, leads to a query about whether *ex post* opportunism will arise in equilibrium.

Second, the absence of unique equilibrium in the static game and the resulting expectation indeterminacy in the dynamic game lead to "game theoretic" concerns about the fundamentals of the model. Typically, models have assumed that expectations move in the "right" direction so that, for example, early choices of one system make other actors expect that system is more likely to win, or an effort by a system seller to make it

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[6] See Besen and Farrell (1994) for complementary supply analysis and references.

more attractive moves expectations in the obvious direction. These are simply
refinements, however, and the deep indeterminacy remains.[7]

3) The Documents and the Market Background

The antitrust case documents are mostly from the period 1994-1998. The period
arises from the main issues in the case, which relate to the commercialization of the
Internet and its potential impact on Microsoft's PC operating system monopoly. I focus
on documents that discuss strategy and marketing of browsers, operating systems, and the
applications-dividing technology Java. This is a substantial body of documents in the
case, which largely concerns distribution strategy in those areas.

In what remains of this section I introduce the areas of discussion and some of the
language that the documents use most extensively.

A number of the documents are drawn from the "browser war" of 1995-1998.
Netscape introduced a browser, Navigator, in late 1994, and that product quickly gained
millions of users. Microsoft decided in spring, 1995 that the existence of an independent
browser was strategically problematic, and introduced its own browser, Internet Explorer,
"IE," coincident with the launch of Windows 95 in that year. Originally, only the
Netscape browser or "client" was available "cross platform," that is, on many different
kinds of computers (including Mac, Windows, including old versions, and Unix), but IE
soon became cross-platform as well. Originally, Navigator was a far superior product to
IE, but the quality difference narrowed as new versions were released, with IE 4 (version
4) equal or better in features (ignoring network effects). By a variety of strategies whose
legality under the antitrust laws is not relevant to this paper, Microsoft ultimately
increased IE's share of browser usage considerably.[8] Since the strategies were debated in
court, there is a considerable body of documents relating to browsers. Since there was a
browser war, these documents will help us examine both the first and second phase of the
theory. In much of this discussion, we see the browser war from the perspective of
Microsoft which, having gotten the late start, feared Netscape Navigator being
established as a *de facto* standard browser, as Navigator had by far the highest share in
browser usage.

Another substantial body of documents concerns PC operating systems (OS).
Microsoft had a PC OS monopoly. The defense attempted to show that this "monopoly"
was temporary, and could be swept away at any moment by a number of alternatives,
while the government attempted to show substantial entry barriers based on an argument
related to network theory, the "applications barrier to entry." This contention led to
introduction of a number of helpful documents. There wasn't an operating system war in
the period covered by the documents, so they largely illuminate the second phase of the
theory, in which Windows is a *de facto* standard operating system. This discussion offers

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[7] See, e.g., Caillaud and Jullien (2001) for the argument that they are mild refinements.

[8] These assertions are believed by both sides in the antitrust case, with two exceptions. The first
is the spring 1995 date for Microsoft waking up to the browser threat. I can't write around that, however,
as we are going to look at a large number of documents from that period which simply cannot be read if
one accepts the defense's assertion that Microsoft was ignoring Netscape at that time because it had already
made the key browser strategic decisions. Second, I use the word "browser," which according to the
defense cannot be defined. We are, however, going to read dozens of documents which can only make
sense if writer and reader know what a browser is. I have argued elsewhere that the unlawful acts were key
to Microsoft's victory in the browser war (Bresnahan 2001) but that doesn't matter here.

a useful counterpoint to the browser one, as we see Microsoft writing from the winner's perspective. Any winner/loser bias in thinking about network theory should be minimized by looking at both sides.

A third body of documents concerns the relationship between the operating system on the one hand and the browser and Java on the other. These largely reinforce the message of the browser and OS documents, with one systems product being all Microsoft, the other being an alliance of (widely distributed among users) Netscape and (widely chosen by developers) Sun.

4) The Theories' Implications Seen in the Documents

In this section, I follow the outline of network effects theory in section 2), looking at elements in both browsers and OS, looking first at equilibrium, then the underlying user behavior that is drawn to more applications (or content), applications (or content provider) supply behavior that is drawn to more users, and systems product providers who would like markets to tip to them.

Network effects leading to multiple possible equilibria in the long run are a core concept in Microsoft's thinking – the browser war could have tipped to either Netscape standards or Microsoft ones. At early stages, the path to long run equilibrium is open to strategic influence. But at late stages, positive feedback plus the tendency of many nonstrategic agents, developers and users both, to have made sunk investments specific to a particular platform make it very hard to change. Compatibility over time is extremely important, as a result. Along the path to a selecting a long run equilibrium, coordination is a complex activity involving expectations, volumes of communication among the to-be-coordinated actors, and the bargaining and other problems that come with coordination games under imperfect information. All of these elements are clear in the documents.

a) Network effects in Browsers

Let me begin with a summer 1996 Microsoft marketing plan presentation on Internet Explorer 3 and related technologies. Many of the ideas from in the theory can be seen in this discussion of the browser market. Figure 1 is the backbone theory slide for the presentation and serves to organize what follows. To put it in context, the slide before this one explains a problem for Microsoft related to Netscape's "Market share, defacto standard." Figure 1, with its positive feedback graphic, lays out the goals and strategies for "turning this around." Like all the documents referenced in this paper, it may be found on the web.[9]

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[9] The entire document containing Figure 1, like the other documents cited here, is on the web. This is a slide from Government Exhibit 488. Other slides from this presentation show a number of quantitative metrics used to buttress the argument.

In what follows I shall use the notation "GX 488" as a shorthand, and the parallel "DX" notation for defense exhibits. Government exhibits can be found at http://www.usdoj.gov/atr/cases/exhibits/, and defense exhibits at http://www.microsoft.com/presspass/trial/exhibits/.

Turning this around

- Key objective is winning the platform API battle
  - Internet Explorer share is key
- Need critical mass and momentum with:
  - Influentials
  - End users
    - Create demand &
    - Broad distribution
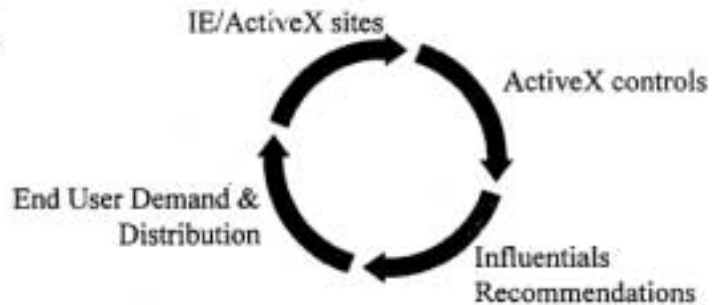 - Builders of websites
  - Developers
- Retention

Figure 1

There is a close correspondence between theory and fact in Figure 1. The positive feedback loop passes through end user demand for IE, and through websites that might be based on Microsoft technologies (IE/ActiveX/ActiveX controls).[10] The slide closely follows the core logic of an indirect network effects theory. To win a platform API battle, browser market "Internet Explorer share is key." To get that share, one needs "critical mass and momentum" with end users, where "broad distribution" will lead to supply by developers and by builders of web sites. One also needs "critical mass and momentum" on the developer / web site side. Getting "critical mass and momentum" leads to the positive feedback cycle graphically shown.

The strategic problem being addressed here is that a version of the same positive feedback is already occurring in non-Microsoft technologies. That cycle might be labeled: End User Demand => Netscape Sites => Java => Influentials => End User Demand. Developers making websites and applications that run on them were focused on Java and Navigator standards and APIs, and end users were using Navigator. Microsoft was, at the time of this presentation, very far behind in browser market share and the resulting positive feedback cycle is moving toward a non-Microsoft LR

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[10] "ActiveX Controls" were (at this time) small computer programs that can run inside (among other larger programs) a browser. They permit website developers to add such features as displaying complex documents (multimedia, databases) in the user's browser. More generally, ActiveX is a Microsoft brand name variously applied to technologies developers use for media, web, etc.

equilibrium. It has not yet gotten there, however, so there is still an opportunity to steer the positive feedback cycle toward Microsoft technologies. .

Of course, the world is more complex than any theory. The rest of this long presentation directs the Microsoft employees who are to go out and influence the follower constituencies of users, website builders, developers and "influentials." That last group, drawn from pundits, the trade press, etc., does not play any role in the theoretical literature – but this does not mean that the theory is not highly useful, for these are exactly the kinds of abstractions we would like theory to make. Indeed, Microsoft used the basic insights of the theory as an analytical backbone while connecting them to the world in direct, pragmatic, operational ways.

i) Reasons for Positive Feedback in Browsers

The positive feedback cycle in browsers arises from both direct and indirect network effects. The behavioral equations of users and of web applications and content developers are, as we see in this section, described and manipulated by Microsoft executives just as the theory says.

In a June, 1996 email to a senior group of executives in Windows and Internet areas, Paul Maritz, number three at Microsoft, wrote about "key issues related to Internet & Windows businesses that we have to address" (GX 42). At several junctures, he worries about the "reinforcement cycle" for Netscape, of which I quote one example in Figure 2:[11]

1. Near-term Browser Share

Without browser share, everything is very hard. So job #1 is browser share. We also have to persuade approx 5 million persons to start using IE over the next 6 months. . We have to stop the Nav-Web site reinforcement cycle with IE3 and shift it in direction of ActiveX. We thus have to get significant shift BEFORE Nav 4 ships, and in so doing prevent Web sites from automatically shifting to exclusively exploit it as they did on Nav 2. IE3 gives us the product that has the features to enable customers to switch, but we need more. Principle actions needed here are:

Figure 2

Mr. Maritz had formed this view quite early. In an April 1995 document entitled "Netscape as Netware" (GX 498) he worries about a "feedback loop [that] drives Netscape market share higher (as content providers encourage its use)." Gains in Netscape "client" or browser market share, if significant, will be "enough that the content providers see more to be gained in exploiting unique features of Netscape clients than in trying to be 'generic' across all clients."

This view was widely shared through the company. Brad Chase, in a 1996 presentation about strategies to raise browser share (GX 684) pointed out that for consumers "all interesting sites support Netscape" whereas for publishers and content providers "80% of web users run Navigator." James Allchin, (GX 489), wrote "Navigator/NetOne provides a new API set -- in near/medium term, Navigator provides the volume platform for ISVs & Corps to target."[12] His proposed response is "increase IE share." Mr. Maritz is clearly thinking of this in specific, quantitative terms in Figure 2

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[11] Here "Nav 4" is version 4 of Netscape Navigator.

[12] He refers to the two important classes of applications developers, Independent Software Vendors and Corporations (for use by employees).

("five million persons") as is Mr. Chase, whose title is "How to get to 30% [Browser] Share in 12 Months."[13]

Here is Mr. Chase in GX 512, using an induction to illuminate the issues.

GOALS AND STRATEGY

We have won platforms battles before, we know what we have to do. We know that we need a very large installed base for our platform (browser and email client share) and we need to drive the adoption of the platform by developers (content developers, corporate developers, solution developers...) so they build content and applications on it.

Figure 3

This view was forged with an eye on the underlying theory. Before they recognized the potential competitive importance of the browser, Nathan Myrhvold and Mr. Gates had an email exchange entitled "Internet" (DX 386). Mr. Myhrvold, "The strength of the Internet is that it is the beneficiary of the positive feedback cycle - more people get on, which attracts more content (and causes more BBS postings) which makes it more attractive for others to get on" and later "Connectivity tends to make the market share leader become even stronger at the expense of everything else, because of increased sharing." Mr. Gates thought (then, in September 1994) that taking proprietary advantage of these network effects would be very difficult: "I think it will be very difficult for there to be a compatible extension of this unless some committee is very powerful or unless we do it." He was about to get a surprise. In an April 1996 memo entitled "Netscape" (GX 41) he finishes with the problem of finding some "Gravity" for Netscape since "Given the positive spiral that Netscape is experiencing what could possibly slow them down?"

ii) Reasons for Positive Feedback in Operating Systems

The theory is general, of course, and should apply (with suitable adjustments for the details) to either OS or Browsers. The thinking among Microsoft's managers, however, is inductive. Much of the source of their analytical frame for thinking about browser positive feedback comes from their earlier thinking about operating systems positive feedback.[14]

Mr. Gates makes the parallel quite explicit. In his May, 1995, memo "The Internet Tidal Wave" (GX 20) he explains why "I assign the Internet the highest level of importance." "The PC analogy is apt for many reasons. …. Aspects of the PC were arbitrary or even poor. However, a phenomena [sic] grew up around the IBM PC that made it a key element of everything that would happen for the next 15 years. Companies that tried to fight the PC standard often had good reasons for doing so but they failed because the phenomena overcame any weakness that resisters identified." He talks about how the Internet has "bootstrapped itself" into a "positive feedback loop." Here Mr.

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[13] This is typical, as, e.g. the Figure 1 presentation does a systematic review of available measurements and data sources -- browser market share, web sites linking to Navigator or IE (mostly suggesting a download) that the developers of web sites are a new audience and "MS' influence over this audience is weak" as 74% optimize their site for Navigator, only 7% for IE. Many more developers already write for Microsoft APIs; however, not Web ones.

[14] I have not seen any allusion in the documents to the Economic theory on these topics, though there are discussions of academic (business school) work on other topics

Gates was following internally an analysis he had published on the original market selection of the IBM PC[15]

> "A positive-feedback cycle begins when, in a growing market, one way of doing something gets a slight advantage over its competitors. It is most likely to happen with high-technology products that can be made in great volume for very little increase in cost and derive some of their value from compatibility . . .. One of the most important lessons the computer industry learned is that a great deal of a computer's value to its user depends on the quality and variety of the application software available for it. All of us in the industry learned that lesson-some happily, some unhappily . . . . .A positive-feedback cycle began driving the PC market. Once it got going, thousands of software applications appeared, and untold numbers of companies began making add-in or 'accessory' cards, which extended the hardware capabilities of the PC. The availability of software and hardware add-ons sold PCs at a far greater rate than IBM had an-ticipated-by a factor of millions.. . .The IBM standard became the platform everybody imitated. A lot of the reason was timing and its use of a 16-bit processor. Both timing and marketing are key to acceptance with technology products.. . . . Although buyers of a PC might not have articulated it this way, what they were looking for was the hardware that ran the most software, and they wanted the same system the people they knew and worked with had."

Note Mr. Gates' mixture of direct and indirect network effects theories, but otherwise his close connection to the basic theory framework.

Andrew Wright, writing in June 1996 (GX 407), made the following interesting positive feedback analogy. Early Windows was not much of a product, but its "promise of a new way of computing and improved productivity generated momentum and ISV loyalty, which has transformed it into one of the most successful franchises in business history." He looks at the then-WWW, and finds that the analogy is precise. While not much of an applications environment at the time, it clearly had the capability of growing into one.

Brad Chase, in his memo "Winning the Internet Platform Battle" of April, 1996 (GX 39) writes that Microsoft needs a "significant user installed base" to attract developers to either IE or Windows. Without that: "The industry would simply ignore our standards. Few would write Windows apps without the Windows user base."

Thinking back to a potential alternative to Windows, IBM's OS/2, Mr. Jones wrote of the implications of being behind in market share "large vendors like Corel, WordPerfect, and MicroGraphix have announced they are abandoning OS/2, it appears inevitable the OS/2 applications market is going to shrink more. . . . . over time the experience of the OS/2 user will become akin to eating a steady diet of stale bread. . . . .there isn't a clear future for OS/2 users". Here we see positive feedback on the down cycle: lack of users leads to applications not being updated, leads to fewer users.

b) Indeterminacy

It is a fundamental result of the theory that markets can "tip" to any of several standards. Many of the documents (including those we have just seen) simply assume

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[15] The quotes are from Gates et al. (1995), <u>The Road Ahead.</u>

this. For example, browser war documents frequently assume that equilibrium browser standards could be either those embodied in IE or in Navigator. The OS documents from this period can consider this only as a counterfactual, considering what would happen if Windows did not have its installed base. Mr. Gates has considered the problem explicitly when he wrote of the establishment of the IBM PC standard, ancestor of the Windows standard, in the time when that was indeterminate: "The PC happened to be a good machine, but another company could have set the standard by getting enough desirable applications and selling enough machines."[16] Brad Chase FY98 Planning Memo "Preserving the Desktop Paradise," 4/97 (GX 512) says that the browser war was going to end with lock in to one standard or the other – but this is the implicit assumption of dozens and dozens of documents. Indeterminacy, *per se*, is not all that important for management, when compared to the mechanisms for resolving indeterminacy in ones' own favor.

c) Leader Advantages / First Mover Advantages / Tipping

Adding dynamics and some element of sunk costs and irreversibility (whether at the individual level or costs of explicit coordination) leads to a second set of implications, that of equilibrium with two phases, the first one, with momentum and matching as the key forces, the second one, with lock-in to a particular standard. Adding strategic supply of systems products, like operating system or browser, means that the two distinct phases of dynamic equilibrium have very different forms of strategic interaction among these firms. In the first phase, before a standard is locked in, the implication is that they will be in a momentum race to recruit complementors, to gain market share with users, and to seek to improve the features of their systems products relative to competing offerings in order to gain that momentum.[17] Once the standard is locked in, positive feedback surrounding a systems product is established, so in phase 2, momentum and comparison to competitors should be far less important. The points about first mover advantages are likely the place where the documents' letting us look at both winning and losing is valuable.

i) Winner's eye view – OS

The indirect network effects locking in the Windows *de facto* standard are long established and powerful. Lock in to the OS monopoly is a fact of life in Microsoft business discussions.[18] Chris Jones, in GX 494, writes of the "traditional operating system competitors (Apple, OS/2, and UNIX)" that "there is simply no chance that we will lose sales because of lack of feature parity with those traditional products." Mr. Jones again, in GX 523, writes, "We are so dominant in all other aspects of the market

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[16] This quote, too, is from Gates et al. (1995).

[17] See, e.g., Besen and Farrell (1994) or Shapiro and Varian (1998) for efforts to draw these and related implications about supply scientifically and as advice to managers.

[18] This part of the positive theory is related to the antitrust case. Entry barriers into the operating systems business (part of the way monopoly power is shown) arise in the government's story because of indirect network effects theory, relabeled in the case as the "applications barrier to entry." See Fisher 1999.

that we can never be displaced by a full frontal assault."[19]   Positive feedback is the essence of that.

Here is Mr. Maritz, in the 1997 Platform plan, writing about a threat to Windows at that time, the Network computer:

The "Network Computer"

- ♦ **World hunger:**
  - ➢ corporations are fed up with cost of ownership of PC's
- ♦ **The cure:**
  - ➢ a "$500 network computer"
- ♦ **The reality:**
  - ➢ functionality very limited
  - ➢ no application base
  - ➢ X-terminals all over again
- ♦ **But the hunger is real!**
  - ➢ giving Sun, Oracle, IBM a new respectability
  - ➢ customers are listening

Figure 4

One important point of Figure 4 are that Mr. Maritz sees real limitations in his own product, Windows, from a customer perspective. To emphasize this, he attributes to his customers a "real" desire to escape from the weaknesses of Windows, characterizing it as "End World Hunger." The external threat, the network computer, has two weaknesses, it is less functional and it has no "base" of applications, i.e., it is on the outside of the network effects enjoyed by Windows. It is not appropriate to conclude from Figure 4 and similar documents that the NC is a more efficient technology locked out by network effects – that would involve parsing the relative importance of the

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[19] Other firms shared this view. The period after the establishment of Windows as a standard saw no important attempts at entry or expansion in personal computing operating systems directly. Firms that took advantage of the shock of the Internet to offer potential threats to Windows' position did so indirectly, either by making devices quite different from a PC (network computer) or by selling complements, not substitutes, for Windows, like the browser and Java. For Netscape's thinking on avoiding a frontal assault, see Cusumano and Yoffie (1998). For Sun's view, consider DX 1285, where James Gosling writes to the CEO about one of several potential strategic goals for Java: "What would 'go after microsoft' mean? A direct frontal assault would be doomed. How about 'lessen microsoft's hold on the software development community and create alternatives for developers' to port to other os's, CPU's..."

network effects and the differences in functionality.[20] But the network effects mean that the mechanism by which customers can influence Microsoft's behavior, is voice, not exit. They cannot realistically switch to an NC, but they can complain to Mr. Maritz.[21] Thus, as a result of the entry barrier resulting from the network effects, we do not have a market test of the propositions that the NC is superior or inferior nor do we know how much more attention Microsoft would have paid to customer complaints if there were competition.

d) Browsers and Tipping

We have already seen some of Microsoft's thinking about positive feedback in the browser market and its sources. The implications for supply are simple, if there is positive feedback, then small market share is a strategically difficult position for a firm.

At all levels, Microsoft thought about the problem as one of breaking the positive feedback cycle working for Netscape. Mr. Maritz, (in a document quoted above, GX 42) goes to the bottom line of a possible tip to Netscape standards in browsers: "I think we may also have to think more defensively. No matter what happens, we have to slow Netscape's ability to drive new protocols/stds [standards] down. This needs quick and serious thought." Recall Mr. Gates' call for finding some "Gravity" for Netscape; the view was near universal in the company.[22] The interesting historical moment in the browser war for thinking about these issues is in the run up to shipping version 4 of both Netscape Navigator and Internet explorer (late 1996, early 1997). Netscape was the browser installed base leader, so that a significant shift to them has the prospect of locking Microsoft out. Microsoft was pulling even in browser features and quality (ignoring network effects), and had been taking advantage of their considerable distributional advantages (competitive and anticompetitive) to keep their browser market share from dropping down to zero. As the version 4 launches approached, they fretted about the possibility of being locked out.

The Microsoft executives were quite specific in thinking that the reason for this was the possibility of the (browser) market tipping to Netscape standards. Recall Mr. Maritz in Figure 2 talking about the possibility that a new version of Netscape Navigator will solidify the tip to Netscape standards. Brad Chase (in the "Desktop Paradise" memo GX 512) summarized the strategic implications: "As Netscape and we approach our respective 4.0 launches we both have a great opportunity to create a significant shift in the installed base. We will not have this opportunity again." Part of the point (as many documents make clear) that Navigator could deliver Java to a wide usage audience and Java-based applications could participate in the tip.

To avoid a tip to Netscape or Netscape/Sun standards, Microsoft executives engaged in a broad campaign of influencing all of the outside agents in the positive feedback loop to move to IE instead. Over time, they added more classes of outside

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[20] I think it has been a mistake of the network effects literature to focus on such welfare counterfactuals. They are too difficult to undertake reliably and convincingly.

[21] Microsoft indeed made efforts to reduce Windows "cost of ownership."

[22] Brad Silverberg, leader of the Internet Platforms and Tools Division at an April, 1996 Division Meeting (GX 40) as "They are smart, aggressive, and have a *big lead.*" Later "The world has changed" in that "Customers have alternatives: we are *behind.*" Brad Chase (April 1996 planning memo, GX 39): "Netscape is already entrenched in our markets all over the world. The situation today is <u>scary</u>." (All emphases in originals.)

agents than shown in Figure 1, and thought carefully through how to influence each group. This provides an opportunity to examine their theory of the outside agents' behavior.

i) Users

On the user side of the browser market, Microsoft used a mixture of direct network effects models and indirect network effects models. One interesting compendium of this thinking is in a long 1996 presentation by Brad Chase "How to get to 30% [Browser] Share in 12 Months." (GX 684) Mr. Chase sketches out a theory of five different kinds of outside agents. From the perspective of "Consumers / Home Users" the point is that "All interesting sites support Netscape" which is "The Internet Standard Browser" but also that it Navigator is the "Most popular web browser" is an effective marketing message for Netscape.[23]

Kumar Mehta, in a March 1997 email entitled "ie data" (GX 204) responding to the question about whether IE should be tied to what became Windows 98, summarizes "all the IE research we have done" (primarily consumer market research by survey.) He writes, "80% of those who do not use IE say that they have no plans to switch to it. which means that if we take away IE from the o/s most nav [Navigator] users will never switch to us." Clearly, Mehta is using a single-user switching cost model, at least in part (some of the reason not to switch may be network effects).[24]

Christian Wildfeuer, writing at the same time about the results of focus groups of Microsoft's most inframarginal end user customers, early adopters of Windows 95, summarized the same issue in this way (GX 202):

> "Most of our IEUs [individual end users] were Navigator users. They said they would not switch, would not want to download IE 4 to replace their Navigator browser. . .. . To make them switch away from Netscape, we need to make them to upgrade to Memphis [Windows 98.] . . . <u>We need to strengthen our key asset and our key brand which is Windows to win the internet war on the desktop side.</u> . . . . convert the Navigator installed base and eclipse Netscape's browser market share leadership. But if we rely on IE 4 alone to achieve this, we will fail." (Emphasis in original)

Around the same time, the more senior Mr. Allchin questions the possibility, even with a "totally competitive" browser offering, that IE would be chosen in the marketplace, writing (GX 48) "Pitting browser against browser is hard since Netscape has 80% marketshare and we have <20%. I am especially worried that we don't have a long term winning strategy. I feel we are street fighting. Even if we get IE to be totally competitive with Nav/Communicator, why would [it] be chosen? They have 80% marketshare. I am convinced we have to use Windows, this is the one thing that they don't have."

Mr. Chase, in GX 39, offers an interesting network effect theory linking individual user lock in and network effects. He recognizes that new users will be easier

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[23] Mr. Chase also suggests, chillingly, this course of action: "The Internet is part of Windows. We will bind the shell to the Internet Explorer, so that running any other browser is a jolting experience."

[24] Jonathan Roberts uses the same theoretical frame in GX 205 "the only real chance IE has of getting them to switch is thru a new pc, an OS upgrade, or a new ISP kit."

to attract than existing, Netscape customers, but sees the existing base of Netscape users as "influentials" who cannot be ignored by Microsoft.[25] He reports that it has been hard to get users to switch from Netscape; most switchers have instead come from "second-class" browsers. His solution is <u>not</u> to make the browser itself better, but instead "the best way to make people switch browser is to make sure that they have to, in order to get the best content" – don't move the chicken, move the egg.

The general consensus inside Microsoft, at this late stage of the browser war, was that the entrenched position of Netscape could not be overcome. Bill Koszewski wrote in "Browser Marketing FY99" May '98 (GX 173)[26]

◄ IE 4 is fundamentally not compelling

- ◎ Not differentiated from Netscape v4 – seen as a commodity
- ◎ Increases, does not decrease support costs .
- ◎ No "grass roots" end user demand for the browser
- ◎ Too many B.S. business issues (channels, AD, branding, etc.)

Figure 5

Mr. Roberts again (GX 355) "Customer feedback … if they [browser and OS] are de coupled, then Navigator has a good chance of winning. In a browser battle, victory will go to the incumbent."

Above and beyond the theory's implications, we can see a number of interesting points here. Microsoft marketing people here use market research as an input in planning their decisions, and in a way that it would be hard for an econometrician studying lock-in to a browser standard to replicate. They interpret what users tell them in light of their deep knowledge of the market and technical situation and their experience in understanding how users' remarks about their intentions help forecast their behavior in different supply situations.[27] Finally, our theories tend to cleanly distinguish between individual user sunk costs, direct and indirect network effects, and coordination problems as sources of lock in. Industrialists don't get to make assumptions, of course, so Microsoft and Netscape had to deal with the actual situation of the browser, which involved some of each of these elements. The discussion often (as here) then has less to do with the theory of the industry and more to do with the simple practicalities of attempting to build market share when far behind in a tipping race.

ii) Developers

Microsoft views developers of web content and "traditional" developers of software for sale and in-house corporate software largely as strategic followers who may be influenced in a tipping race.

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[25] He is not, I think, using "influentials in the same sense as Figure 1, but in a contagion-theory sense of adoption of technology.

[26] Similarly, a February 1998 "Business Outlook for Platforms-Desktop" presentation reports "Key customer feedback" on Internet Explorer: "Many customers see MS and NS as parity products; no strong reason to switch." GX 428.

[27] These documents also speak fairly directly to what Microsoft thought would have happened if they had not undertaken their anticompetitive campaign against Navigator, but that is a matter for another paper.

PUBLISHERS AND CONTENT PROVIDERS	
NETSCAPE	**WHAT OUR MESSAGE SHOULD BE**
We Will Continue to Be The Share Leader • 80% of Web users run Navigator. • We are committed to cross platform. • We are bundled with all access providers.	Significant Client Share • We're bundled with the OS, our share is going to grow. Pay attention. Incentives

Figure 6

Here we see Mr. Chase again, bringing out the key elements of the positive feedback loop. [28] For example, he takes the perspective of "Publishers and Content Developers" and notes that the advantage to Netscape comes because "We [Netscape] will continue to be the share leader / 80% of users run Navigator" For both audiences, an advantage of Navigator is that it is "cross platform," that is, runs on any kind of computer. But here, in Figure 6, addressing publishers and content providers, he has a far simpler message. Against Netscape's marketing message (true) that Navigator can provide the largest group of browser users, he provides the alternative marketing message that Microsoft's share will grow over time, because of the bundle with the operating system.

Because of the high share in browser usage enjoyed by Navigator, Mr. Maritz forecast that website developers would be tied more and more into Netscape standards (cf Gx 42) as websites became more complex and had more features calling for potentially proprietary "protocols." The complexities would involve more and more use of such features as hosting threaded discussions, viewing and searching collections of messages, and the like. Similarly, Microsoft fretted regularly about the possibility that developers would become linked into non-Microsoft document formats, and noted that Netscape had moved forward to make it easier for developers to embed those in their web pages. But by far the bulk of the discussion of developers followed the layout also used in Figure 1, that is, assuming that the non-Microsoft standards which would lock in would not be those of a single other firm, but would surround an alliance systems product that consisted of Sun's Java and Netscape's Navigator. The reasons that this alliance was so considerably threatening was that Navigator, as we have seen, had considerable distribution to end users. Java, complementarily, enjoyed considerable developer "mindshare." Thus many of the discussions of applications developers in the feedback loop revolve around Java and the possibility that Java cold achieve network effects through gaining widespread (end user) distribution through the alliance.

There are actionable implications of the theory which have not yet been tested but which lead to management decisions. Use of the theory's insights went down to the quite detailed and quantitative. Mr. Gates (in GX 41 cited above) made the correct theoretical argument that "I think outside the United States we can catch the browser war at an earlier stage which is a lot easier." Mr. Chase (GX 465) operationalized this by giving higher market shares targets to marketing teams in different countries, conditioning on

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[28] Chase brings more kinds of economic actors into the positive feedback loop, such as corporations developing intranets (where the same buyer is both user and developer) and independent software vendors (whom he distinguishes from content providers.)

the degree to which Netscape was entrenched. [29]   Management decisions about resource allocation and delegation, not just ideas, flow from the theory.

5) Underpinnings of the Theory and Key Limitations

a) Roots in sunk cost by followers

One of the fundamental issues in the literature is about the possibility of influencing network effects at different stages of their development. It is easier to influence the direction of a positive feedback loop early. A key assumption here is difficulties in coordination among the nonstrategic actors (users and developers) and/or of standard-specific costs sunk by those actors. Mr. Myrhvold and Mr. Gates ("you" in the quote below) discussed the logic of lock in theoretically in the "Internet" exchange of September 1994 (DX 386):

> In the last couple of years we have seen a lot of new protocols and programs sweep the Internet - the time it took everybody to swing around to Mosaic was stunningly fast - but this is because it was expanding into a vacuum. The helter skelter world of protocol du jour is perfectly suited for email (where it does not matter much) or user contributed content, because in each case the content is ephermal [sic] and is quickly replaced. When you start to assume lots of rich content and transaction services you start to act a lot more like the PC market - standards change slowly, ISV buy in is important, there is value to being a kingmaker funding major new work and evangelizing it etc. That is a role which we can play.

The inductive mode is strong here again, as Myhrvold sees the Internet becoming like the PC market, but this enables him to make a general theory point. Once followers start making investments that are "rich" and complex applications, i.e., start sinking costs, the industry will transit from a volatile state into one where standards have more persistence. And that is the key, he argues, for firms in the systems layers to take a leadership role, i.e., be "kingmakers."   Mr. Gates had published a similar point about timing with regard to the PC (equilibrium was indeterminate at an early stage, but IBM got there and set the standard, later equilibrium was far harder to change, timing was very important. Cf. Gates et al. (1995))

Mr. Myhrvold and Mr. Gates also took up the question of whether this would lead to the technologies and industry structure that the follower actors would prefer, and, if not, whether they can contract or organize to get the outcome they want. From the same email exchange (DX 386):

> "Content developers will try to remain platform neutral, tool neutral and format neutral, and for the most part they will fail. Once people start to compete they will increasingly become platform and tool specific if there is any advantage in doing so. This includes both the computing platform (i.e. Windows) and also the online service environment . . . . This will create a new inertia in changing standards."

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[29] This interesting remark leads to a standing effort to "out-localize" Navigator and some frustration on Microsoft's part when Netscape turns out to be good at non-English version.

As you can see, Microsoft executives have examined the potential "Coasian" or "price theoretic" limitations of standard standards theory and rejected them. That is why they believe that, when "follower" actors are unhappy with a standard they do not self organize, but instead look to vendors of systems products to liberate them with a new standard.[30] Gates and Myhrvold follow the natural modeling tendency that the follower agents are smart and foresighted, but that there is an externality. All the followers would have to act together to defeat the strategy, and that would be prohibitively expensive to coordinate especially as the more technically aware followers, the developers, are in competition with one another. Mr. Myrhvold thinks that only a "large player who can create something significantly new and evangelize it successfully" can lead to a new standard.[31] Efforts of the smaller players to have technologies develop the way they like "for the most part . . .will fail."

As in any large social system, there are certain limits on the ability of leaders to exploit followers, and thus limit to the model of Microsoft as leader, users and developers as atomistic, nonstrategic followers. In some circumstances, outsiders act outside their own individual self-interest, coordinating on strategies that matter for the leaders. For example, a Microsoft team was sent off to find out about Netscape's revenue sources, with the goal of knowing enough to put the firm out of business.[32] They reported back "Sorry this took quite some time . . . . Customers/ISPs [Internet Service Providers] don't want to talk about it because they all know we are out to get them [Netscape]." Relatedly, there is a strong tendency among many developers to prefer open standards even when their self-interest is as described in DX 386. Computer people use the label "religion" to describe this behavior and it makes the costs of managing the network effects around a proprietary system rise. Yet the core insights of the theory remain, just as they would be true if there were stronger (purely rational actor) preferences for open-ness on the part of the followers.

b) Expectations

When the static LR equilibrium is indeterminate and equilibrium choice plays out over time, the theory tells us that expectations can matter – leaving even the dynamic result indeterminate, as "vaporware" pre-announcements can affect equilibrium. Refinements of the expectations formation mechanism can return uniqueness, but then the question is which refinement. These fundamental game theory questions appear in the documents, which gives us a rare opportunity to examine them.[33] For this purpose, I look not only at Microsoft documents in which the firm talks about the expectations it would like to set, but at other firms' expectations as well.

Expectations formation and expectations management are important strategies for a systems product seller attempting to gain cooperation from complements. Here is part

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[30] These elements run strongly in Mr. Maritz' analysis of the Network Computer in Figure 4.

[31] It would be interesting to learn if he still believes now that the large player must be commercial, after the open source movement demonstrated some positive features. In any case, his view of the nonstrategic actors as followers is unlikely to have changed.

[32] To "cut off their air supply" in Mr. Maritz' colorful phrase.

[33] See Dranove et al (1999) for an econometric examination of expectations and "vaporware" and a review of the relevant theory.

of Mr. Chase' analysis we looked at above (GX 684) contrasting Netscape and Microsoft <u>messages</u> to a key outside constituency:

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Figure 7

Chase clearly thinks that expectations are important – and can be influenced. Note that he sees both Netscape and his own firm communicating to publishers and content providers about the equilibrium of the whole market, including the behavior of end users.

Microsoft did send out this message, and it was picked up in the broader marketplace. After having been briefed about a Microsoft presentation at an influential Silicon Valley venture capitalist's offices, Mike Homer of Netscape wrote in an email:

"M/S thinks that with a client competitive with Netscape's (doesn't even have to be better or equal, just comparable) and IE bundled into every Win95 desktop from Q4 1996 on, it ultimately wins the client war (that's 3-4MM more browser seats every month!). . . . And by winning the client war, M/S secures dominance for ActiveX and marginalizes Java. That is the Microsoft endgame for the Internet client market as far as I can tell."

Kumar Mehta of Microsoft thought the message had been received in corporations and by webmasters in March 1997 (in GX 205) "from all our research with IS [corporate Information Systems] and web professionals we know that they eventually expect us to win the browser war because Ie will be bundled with the operating system and they will have no real reason to purchase navigator."

Note again that Microsoft sees not only itself, but also complementors it is trying to influence, forming expectations about industry equilibrium ("win the browser war"). It is no surprise that the industry has built up a vocabulary about managing expectations, with phrases like "developer mindshare," which refers to developers thinking about which platforms might be suitable for their applications recurs steadily or into the verb "evangelize," which refers to platform sponsors' efforts to inform and convince developers about their standards and technology.[34] Here management practice contains the essence of the theory but is, naturally, more complex.

i) Refinements

The story is more interesting with expectations formation by agents whom it is not appropriate to view as nonstrategic followers. A good example is AOL, which, as the largest Internet Access Provider, was a potential complementor to either Netscape or Microsoft. Both Netscape and Microsoft were attempting to gain AOL's cooperation in early 1996 – also a time when Microsoft and Netscape were both sending the "it will tip

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[34] Microsoft spends a good deal of time measuring developer mindshare and has literally thousands of employees working in developer relations.

to us" messages we have just seen. AOL is far too influential to be treated as an atomistic follower, and AOL's expectations formation followed complex and interesting logic.[35]

Here is series of quotes from an email inside AOL (GX 38) at that time. David Colburn of AOL is reporting on a negotiating visit to Microsoft, attempting on his side to have AOL be paid a great deal to give its customers the browser they did not want (IE) [36] Microsoft encouraged the strategically important AOL to believe this story, but the two firms were in the middle of negotiations of how much Microsoft was going to pay AOL to help in the effort to tip.

> 5) Interesting to note the contradiction between their claim of manifest destiny re: winning the internet software battle, and their eagerness to bring us into their fold. In terms of timing--we are absolutely of greater value to them post-Netscape, as a decision to shift from Netscape after a public alliance is even better that a pre-emptory strike today (deployment issues aside). Msft is clearly feeling vulnerable over the next year so.

In paragraph 5) "their" is "Microsoft" and Colburn is deciding not to believe the Microsoft theory of tipping. His logic tells us something very interesting about expectations formation in the context of <u>negotiation</u> to tip among strategic players who are incompletely informed. AOL, a strategic player, is being quite careful to make its own assessment of the likelihood of tipping, rather than listening only to Microsoft's or Netscape's. Even more interesting is Colburn's rejection of the usual refinement is false. Rather than infer that a favorable offer from Microsoft to him means that things are more likely to tip to Microsoft (typical rational expectations refinement logic) he infers from the very fact that they are negotiating that they need AOL (typical bargaining theory logic.)

He also reports on Netscape:

> 9) The essential NS proposition is that they get out of the online services business and we get behind their struggle for survival. Thus, a stable partnership. From time to time NS fails to recognize this. A delay in our negotiations may help them to understand.

Figure 8

This analysis is closely related to bargaining theory. Note the analysis of the threat point from the bargaining partner's perspective ("their struggle for survival.)" Note the belief that delay and expectations in negotiations interact, in a way familiar from the theory of strikes. It seems clear to me that in the broadest sense economic theory was right to say that the information economics tells us how to refine away multiple equilibria, but also that the exact refinement to use depends in a deep and complex way on the specific circumstances of the industry and the parties.

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[35] Charles Ferguson, another interesting pragmatic theorist of network effects, writes interestingly of this in his 2000 book. Dr. Ferguson was, in his role of a software entrepreneur, in negotiations with both Microsoft and Netscape.

[36] The email is interesting for the light it throws on that effort, as Mr. Gates is reported to have delivered "a characteristically blunt query. How much do we need to pay you to screw Netscape?? ('this is your lucky day.')." Gates ultimately paid through the nose, putting an AOL icon on the Windows desktop, which at this stage of the negotiation he said was "sacrosanct" (p. 2).

Perhaps the most interesting piece of information economics in here is the complex interaction between the actions of strategic players and its impact on follower's beliefs. In paragraph 5), "a decision to shift from Netscape" later, after supporting Netscape, is better for Microsoft than "a pre-emptive strike today", even though a later shift is worse in terms of direct impact on shares ("deployment issues aside") because of what the later shift signals to follower actors.   Reading documents like this should lead positive economists to exhibit more fondness for information-theoretic approaches to coordination and bargaining.[37]

6) General Equilibrium and Ending Lock-In

The Microsoft documents also include lines of analysis that go substantially beyond existing standards theory. Dynamical network effects theory has emphasized the transition from an early period of technological uncertainty to a period of in which choices are never reversed.[38] Microsoft, has an analysis of how they might end. Their analysis starts by adding more "layers" of complementary products to the standard users/systems product/developers triad. This shift to general equilibrium changes the partial equilibrium story radically. Since Microsoft uses a detailed set of linked analyses to understand this, I shall now switch to a more inductive mode in which I first report their line of thinking, then link it to theory.

a) Disruptive Change arrives via complements

Microsoft has an explicit theory of the mechanisms by which lock-in to a standard may <u>end.</u> It arises from their analysis of general equilibrium quite directly.[39] The first ingredient in the theory has to do with disruptive technical or market change that comes

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[37] Particularly those who like rational expectations equilibrium concepts. Microsoft's internal thinking was very close to AOL's guess: (Mr. Slivka in 1/96)

> Summary: If AOL gets it's logo in Windows box, they will use
>   our technology. For me, it's obvious that having AOL
> on our side (as opposed to Netscape's side) is worth
>   this cost -- we get folks who have been very successful
> marketing to consumers endorsing our technology. That
> gives us AOL, CIS, and MSN selling our client technology --
>   just like we had Compaq and IBM in the early MS-DOS days.
> Having AOL steer there 4-5 million customers to Netscape
>   is a scary thought.

[38] To use the theory positively we would, of course, take the slightly more stylized implication to be that the system moves from a more malleable state to a less malleable one. If the costs of moving from a locked-in equilibrium are large but not infinite, then there will be persistence, perhaps punctuated by periods of change when an innovation large enough to overcome the lock in arrives. See Bresnahan and Greenstein (1999) for an effort to explain the (low) frequency of platform shifts in computing along these lines. See Shy (1996) or Aggliardi (1995) for a formal theory of "large enough."

[39] This played a role in the antitrust case, which did not challenge the Windows monopoly circa 1995 saying that the market had inefficiently locked in to it (as many have suggested). Instead, the government asserted that new competition that would have been brought by the commercialization of the Internet was blocked by anticompetitive acts. There is an irony in the common argument that the "case was based in theory" while the relevant part of the case was the thing the theory has not reached.

from complements – in the documents, complements related to the commercialization of the Internet

The background here is that the Internet was, for its first twenty years, used far from Microsoft's main markets in end-user commercial computing.[40] The Internet advanced in a technical sense while having no important connection to the PC. After the introduction of the WWW, junior Microsoft employees saw the more end-user oriented trend on the Internet as relevant to the PC business, but despite their gaining a substantial meeting with Mr. Gates in Spring 1994, the company did not focus on the importance of this particular disruptive change until a year later. What happened in the interim was that Netscape, a startup founded by the young inventor of the browser and some much more experienced technology business people, successfully undertook what Mr. Gates thought (in 1994) was impossible (see quote from DX 386, above) and introduced a client embodying the unlikely "compatible extensions." Navigator, introduced in late 1994, was an instant success, and well on the way to dominating the browser market. Microsoft realized that there was a problem and hurried to catch up with their own browser.

Much can be learned of their thinking from the time, in spring 1995, when Microsoft's senior management grew aware of the potential browser threat and the firm turned to deal with it. Many Microsoft internal documents talk about this disruptive surprise and how important it is to change one's thinking to deal with it. A frequent metaphor is the browser as "Trojan horse" – an application running on Windows, but there are competitive surprises in it. Another interesting metaphor is "change the rules" enabling competition where it had been impossible before[41]

Mr. Gates emphasized the disruptive change elements in "The Internet Tidal Wave", GX 20, which we have seen above. The disruptive surprise element is strong. Mr. Gates opens his memo by saying "Our vision for the last 20 years can be summarized in a succinct way" in order to point out that this long-stable vision has been obsoleted by developments in complements. "The Internet is the most important single development to come along since the IBM PC was introduced in 1981," even more important than the graphical user interface "The Internet is a tidal wave. It changes the rules. It is an incredible opportunity as well as incredible challenge." Elsewhere (GX 336) "the widespread adoption of the Internet is a sea-change." (Emphasis added) Movement of a longstanding technical capability, the Internet, into widespread use by Mr. Gates' customers is a key step in indirect entry.

Mr. Gates (GX 20) correctly forecasts that the Internet is a very valuable complement to the PC: "the Internet will help keep PC purchasing very healthy for many years to come." Yet he argues that the Internet has made some heretofore not very threatening competitors, like Sun, much more of a competitive threat. Most importantly a "new competitor, born on the Internet, is Netscape. Their browser is dominant, with 70% usage share, allowing them to determine which network extensions will catch on." That last part means that Mr. Gates forecasts Netscape will be dominant in setting interface standards between the Internet and the PC. Even though they are selling a complement (as is Sun) he views their popularity as a competitive threat.

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[40] Greenstein and I (1999) call competitively distant technical development the first stage of "indirect entry."

[41] Mr. Muglia, August 1996: "'97 Tools Vision" "The Internet has changed the rules and opened up opportunities for new competitors."

This entry by way of complements is the first element not in received theory. The logic that explains it comes from thinking carefully through more of the implications of network effects theory.

Any theory of the end to positive feedback cycles and breaking out of lock in needs to posit some kind of change that is important enough to break the cycle. Disruptive technical change is one obvious candidate, or cumulated technical change that crosses a sufficient threshold to be important enough to break the lock in. Microsoft, understanding the lesson of the "Arrow effect" very well, has long determined to let no forecastable technical progress, like the accumulation of incremental technical change, weaken its position. It is also well posed, as the incumbent in the operating systems market, to win a standards race against any direct OS competitor, even one using new technology.

The core argument here follows simply from repeated application of the network effects logic. Any particular cluster of network effects may well be locked in so that a direct replacement, even a substantially superior one, is locked out. If the systems firm benefiting from the indirect network effects keeps the technical level of its product reasonably close to the best available alternative, disruption would have to come from a very rapid rate of improvement in alternatives, rather than the accumulation of those improvements. This can reduce the real-world likelihood of a direct disruptive change nearly to zero. The same logic does not apply to complements, especially innovative complements. Those may gain a large market without needing to take on the existing network effects. Positive feedback around a complement, i.e., the complement having its own network effects, can give it widespread distribution very quickly, i.e., turn a potentially disruptive technical opportunity into an actually disruptive market outcome.

Thus far, what we have is a story of why entry by way of complements may gain a market where entry by way of substitutes would not. The next step is understanding why the presence of a widely distributed complement is a threat, not an advantage, strategically.

b) Divided Technical Leadership and Competition

Microsoft viewed certain key features of the browser and Java as converting them from mere complements to competitively dangerous complements. As we have already seen, the ubiquity of the browser was part of the problem. The second feature was the status of the browser as potential "middleware," that is, software which exposes APIs to developers, and of Java as actual middleware. The browser and Java were outside Microsoft's strategic control even when they ran on the Windows operating system. They were even more independent because they were "cross platform," that is, the browser could run not only on a Windows PC but also on other kinds of computers, and Java could be used to make applications which run on different kinds of computers, not just Windows PCs. This divided technical leadership[42] leads to two separate and distinct problems for Microsoft, competitively. They viewed the browser, and later, Java, as an enabler of competition for Windows. And they viewed the browser, and later, the browser plus Java, as current complements that might become future substitutes for

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[42] Shane Greenstein and I (1999) introduce this term for clusters of partially overlapping network effects serving the same demand. I (1999) pointed out that the addition of new complementary layers can add new opportunities for divided technical leadership and thus to restart that kind of competition.

Windows. Microsoft viewed the existence of a second, partially overlapping cluster networks effects, centered on systems products it did not sell, as future competitive problems for Windows.

The core of Microsoft's worry about the browser <u>as an enabler of competition for Windows</u> came from its cross-platform nature. Mr. Gates' <u>Internet Tidal Wave</u> memorandum stated the nature of the problem in clear terms: "They [Netscape] are pursuing a multi-platform strategy where they move the key API into the client [browser] to commoditize the underlying operating system." By what means would the operating system become a commodity? "One scary possibility being discussed by Internet fans is whether they should get together and create something far less expensive that a PC which is powerful enough for web browsing." As we saw above, Microsoft was untroubled by direct challenges from cheaper PC substitutes; only with the independent browser was the entry likely to succeed.

Others agreed with Mr. Gates in seeing Netscape's innovation as bad for Microsoft through enabling operating system and hardware competition. Ben Slivka (1995) wrote a memo with "a lot of material" in the same time period entitled "The Web is the Next Platform" GX 1016. In it the "Web is a threat to Windows." "My nightmare scenario is that the Web grows into a rich applications platform in an operating-system neutral way, and then a company like Siemens or Matsushita comes out with a $500 'WebMachine' that attaches to a TV. . . . When faced with a choice between a $500 box . . . and a $2Kpentium P6 Windows machine, the 2/3rds of homes that don't have a PC may find the $500 machine pretty attractive." This dramatic increase in competition for Windows with a new body of customers arises not because the anticipated "WebMachine" can run a wide range of PC applications, but because it "will let the customer do all the cool Internet stuff." The existence of a new cluster of network effects around the browser partially undercuts the value of lock-in to the Windows OS standard.

Much the same kind of thinking meant that a successful independent browser and Java would lead to lost market power in Microsoft's sales to corporations. We saw above that the Network Computer was not in a position to enter corporations alone. In a 1997 planning memo titled "Preserving the Desktop Paradise," (GX 512) Brad Chase wrote that Sun and Netscape "endeavor to commoditize the OS" and that Java and the browser are "precisely the technologies . . . that may make the NC viable."

c) DTL and Competition II: Developers

Maintaining a monopoly position buttressed by network effects calls for keeping not only user demand but also developer investment and "mindshare." A complement which itself can be the center of indirect network effects has the prospect to draw some developer attention, thereby attenuating the degree of monopoly power accruing to existing products. Of course, this is contingent on the complement having the technical features that permit developers to write to it (sometimes called "platform" attributes in the documents, sometimes "middleware" ones.)

Mr. Muglia (August 1996 "'97 Tools Vision" memo to Developer Tools Division) wrote that when the focus of applications development moves away from Microsoft's APIs to others, this contributes to the momentum of the new, complementary cluster of network effects. This can lead to new competition by "potentially opening up the opportunity for our competitor to slide in its own operating system offering." The

mechanism is closely related to the one we saw in the last section. First Sun's Java and Netscape's Navigator are drawing "developer and content provider mindshare." Then "**The Result—People Aren't Writing to Our Interfaces.** The solutions people have implemented today do not benefit Windows uniquely – they work on all platforms equally well" (emphasis in original.) Mr. Muglia is arguing that when developers take advantage of a complement to Windows, it weakens the lock in to Windows and opens up the possibility of competition.   Mr. Gates agrees (GX 336) "Netscape's strategy is to make Windows and the Apple Macintosh operating system all but irrelevant . . . hoping that its browser will become a de facto platform for software development, ultimately replacing Windows as the mainstream."

A crisp graphic on the future competition arising from current divided technical leadership (Mr. Maritz in the 1997 Platform Plan (GX 490):
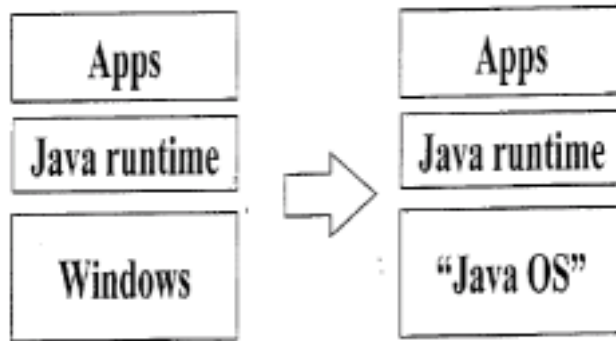

Figure **9**

Here is Mr. Maritz in GX 42 on why to avoid divided technical leadership.

The need here is to fundamentally blunt Java/AWT momentum and to re-establish ActiveX and non-Java approaches as a viable strategy for structuring software, in doing protect our core asset Windows - the thing that we get paid $'s for. While Java per se is not the problem, if everything & everybody moves to Java as a language, then it will be so much more easy for AWT to become the API, and Windows is damaged.

Figure 10

It is worth understanding just a bit how the lack of applications for new competitors for the OS and the existing commitments of applications developers to Windows play out. Here is Mr. Chase on the subject in March 1998. (Gx 828)

"If we lose the developers, we will ultimately lose the platform. Our goal is to build a community of developers and web professionals that emotionally and economically value Microsoft, our products, platform, and tools. Competition is aware that 'our' developer community is a key MS asset and are working [to] divert developers from Windows." His "key metrics for this goal" include ">90% of developers targeting Windows" and ">80% of Java developers writing native Windows Applications."

In a sense, the key words here are "our" and "asset" – Mr. Chase clearly views the developer body as potentially mobile, but having considerable commitment to Windows. The system-specific sunk costs of developers make them behave inertially and are a valuable strategic asset for Microsoft – that is a nice way, Mr. Chase, to link strategic entry deterrence theory and network effects theory

Mr. Maritz, alarmed, in GX 490 summarized the two key features that make a complement into a sponsor of competitors or a potential competitor itself: widespread usage and potential developer attention: "Netscape: The first "middleware" layer to have end-user momentum**".**

d) Strategic Motive for Vertical Integration

Mr. Muglia, in the document we have just seen, makes the case against permitting divided technical leadership very clearly. Like others, he thinks Microsoft is "so dominant" that "we can never be displaced by a full frontal assault. However, when we do leave a hole in our strategy, there are many companies eager to move in and try to leverage this hole to grow into our other businesses. " The business policy implication is to prevent any other firm establishing a complement to Microsoft with its own positive feedback loop by not having "a hole in our strategy," that is, by integrating into all technologies.

Mr. Slivka, in "The Web is the Next Platform," is unwilling to have any vertical disintegration within the class of technologies lead to opportunities for competition. Mr. Slivka was very clear about the issue in GX 1016 writing that Microsoft must "be *the product supplier of choice* for all key existing Web technologies – clients, servers, and publishing tools, at a minimum." The consequence of leaving some gaps is shown in Figure 11. The key to the profitability of the company will be lost, for they will risk losing the standard setting role they have in operating systems and in Office:

1.2.   Why do we need to start from the Web today?

If we don't quickly become the supplier of choice for Internet technology, the Internet will grow and change under someone else's influence, and we risk losing the standard setting role (with the attendant profit margins) we have come to enjoy with MS-DOS and Windows (and Office).

Figure 11

The origins of this view are again inductive. When a complementary technology has its own positive feedback loop, that is strategically problematic. Mr. Maritz explicitly made the induction in "Netscape as Netware" (GX 498) in analogizing the browser to Novell's networking technology. He wrote "The analogy here is that the major sin Microsoft made with Netware was to let Novell offer a better (actually smaller and faster, with simpler protocol) client for networking. The[y] got to critical mass and can now evolve both client and server together. Hence we had and still have a really hard time displacing Novell at the server." Mr. Chase, in "Preserving the Desktop Paradise" (cited above, GX 512) uses heavy emphasis to widen the analogy to email servers from other companies. Finally, Microsoft executives were so sure that a platform technology that spanned and abstracted Windows would increase the competitiveness of Windows' environment because they had seen the operating system span and abstract the IBM PC. They knew, from that experience and many others in the PC business, that real threats could be encouraged by complements to their product, just as Microsoft's position in the operating systems business had been strategically difficult for IBM, the PC dominant firm. That is why Mr. Slivka, for example, summarized (in GX 1016) the threat from the web by saying someone (likely Netscape) is going to "pull a Windows."

This model of why there is a strategic motive for vertical integration hinges on removing divided technical leadership. Its logic departs fundamentally from the analysis of integration strategy in the networks literature, which emphasizes pricing opportunities. It is closer to the logic of vertical foreclosure as a way to discourage entry[43], but the particular importance of these ideas in network industries is not brought to the foreground in that literature either.

e) *Compatibility Decisions*

Microsoft's thinking about partially overlapping clusters of network effects is an important nexus for investigating compatibility decisions. The theory has spent a good deal of time on decisions about compatibility in competitive situations, and on the role of "converter" technologies – those which permit a user or developers who have made sunk investments specific to a platform to take advantage of those investments while using another platform (see, e.g., Farrell and Saloner (1992). Bundling in such circumstances has also received attention (e.g., from Matutes and Regibeau (1992)). Microsoft's thinking is related to the core logic of the theory, but the application is unanticipated in the theory. Microsoft analyzes converters and bundling from the perspective we have just seen, that is, in general equilibrium of overlapping clusters of network effects.

Microsoft starts from the same point as the theory, which is that the nonstrategic actors would like to be able to switch from one system product to another – customers and developers like choice. Further, this choice could either be static, that is, one could choose any kind of computer in the present and gain all the network effects, or dynamic, that is, one could migrate to a new and superior form of computer with minimum loss of network effects.

The mechanisms by which follower actors might get these benefits are not, however, literally converters. The threat wasn't literally converting Windows applications to run on Macintoshes. Instead, a cross platform browser, or a cross platform Java environment, might attract (respectively) users who would like to browse the web from any computer or developers who might like to write applications that would run on any computer. These complements, because they might "span" or "abstract" the operating system, play the role of converters[44]. Further, such a "converter" embedded in a complementary technology has a marketing advantage from being cross-platform.

This leads to two separate Microsoft technology management doctrines. First, when in danger of being "spanned" by a complementary converter, a useful counterattack is to make one's own version of the complement cross-platform as well. Thus, for example, Microsoft made its IE browser run on computers other than the latest Windows, such as Apple Macintosh. Indeed, in one of the more memorable moments of the browser war, they compelled Apple to heavily favor IE over Navigator.[45] Microsoft sought to make it's own version of Java (introduced to prevent spanning by Sun) "enough x-platform to be competitive." (GX 52) This takes away the selling point of the spanning technology, and removes the possibility of it becoming a converter.

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[43] See, e.g, Hart and Tirole (1990).

[44] See, among many, many such references, the discussion in GX 233. Some of the discussion is quite subtle. See, e.g., GX 503, where ISPs want a cross-platform browser (because their customers do).

[45] A slightly odd behavior if IE was an operating system improvement, don't you think?

The same converter point applies in reverse, when the firm seeks to itself "span" an existing technology and undercut its cluster of network effects. Microsoft calls this "embrace and extend." Mr. Gates explained this clearly in the Internet Strategy Day keynote address:

> So the Internet, the competition will be kind of, once again, embrace and extend, and we will embrace all the popular Internet protocols. Anything that a significant number of publishers are using and taking advantage of we will support. We will do some extensions to those things.
>
> This is exactly what Netscape does. They support all the standard protocols, but in the case of things like frame sets or tables or what was called light script, they chose to make extensions. Now, those extensions can be cloned by someone else. Likewise, all the extensions that we make will be clonable by other people. And so you get the interesting question, will it be a case where everybody's tied in doing these things; in which case you've got about zero value, or will one party or another be ahead in this?

Figure 12

Mr. Gates, in DX 400, put this in a very interesting way. He wanted to "make Microsoft products the cornerstone of [anyone's] internet access strategy." He views the problem as one in which the "key here is to find places where Microsoft can set *de facto* standards without competing with the existing standards bodies." He was writing in 1994, when he thought the Internet was run by "standards bodies" like the IETF, a bit simpler to deal with than Netscape. But note his core point – the way to make a converter, and thus to render external control over a technology powerless, is to move in through a complement, not a substitute, "without competing." It is, of course, a difficult problem to make such extensions profitable; to do that, one must ultimately bundle them to other proprietary technologies. Mr. Maritz wrote (in GX 503) that the strategic point was to "Get control of, then leverage the programming model" used by developers. Mr. Chase (in the GX 684 document we saw above) emphasized the need to "We have to get serious about extending and owning HTML [standard, open format for web pages] as a format, and in the process leverage our existing assets to get ahead." The point, then, of turning a complement into a converter is not only to render an outside technology, whether proprietary or open, toothless and thus end divided technical leadership. It is also to convert those outside technologies into Microsoft proprietary technologies. This would appear to be a disadvantage to consumers and developers of this particular approach to the supply of converters.

7) Conclusion

What I have tried to do in this paper is bring forward those remarks by the business people – candid remarks with a strategic or managerial purpose – that illuminate the theory. This has two quite distinct parts. First, an extraordinary number of the issues and ideas raised in network theory play a substantial role in the businesspeople's thinking and acting. I refer here not only to the positive feedback and lock in economics, but also to the economics of imperfect information in bargaining, to theories of leadership as selection of equilibria, and to the impact of asymmetric information in a coordination game (or bargaining game.) This industry, and this firm, may be extraordinary in (i) the need for and (ii) the capacity to form and clearly articulate, these kinds of ideas. Yet there is a remarkable congruence between theory and practice.

Second, in several ways, and here I do emphasize narrowly the positive feedback and lock in stories, practice is richer and more thoughtful than theory. In particular, practice has had to deal with the general equilibrium problem of multiple, partially overlapping clusters of positive feedback. This leads to some important ideas having to do with why vertical disintegration is more competitive in network industries because it leads to divided technical leadership. This is not idle thinking; like the places where practice and theory agree, it leads to very complex doctrines of technology strategy. Inductive method has something to say for itself.

Finally, let me say that while I admire the craft and analytical thinking one finds in the Microsoft documents, and find the ideas highly useful in informing my positive thinking about network effects and lock in theory, no one should confuse that with normative admiration for what they accomplished. All that brilliance was spent to slow down the rate of technical change resulting from the commercialization of the Internet so as to give Microsoft, imitator not inventor, enough time to ponderously take proprietary control of it.

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