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Stanley M. Besen; Joseph Farrell

The Journal of Economic Perspectives, Vol. 8, No. 2 (Spring, 1994), 117-131.

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Choosing How to Compete: Strategies and Tactics in Standardization

Stanley M. Besen and Joseph Farrell

Compatibility standards, once mainly a preoccupation of technical specialists, have recently moved to center stage in the computer, telecommunications, and consumer electronics industries, as people increasingly wish to participate in networks that allow them to share databases, have access to large selections of compatible software, exchange documents, combine products made by different vendors, or simply communicate directly. In these industries, standard-setting has been transformed from an internal matter for individual firms to a subject of cooperation and competition among independent players. The strategic issues raised by these developments include both policies towards vertically related firms and policies toward horizontal competitors.

A firm's strategy toward vertically related firms—the suppliers of complementary goods—normally involves trying to encourage a generous supply of complements, while perhaps also trying to discourage the supply of complements to rivals.¹ Strategy towards horizontal competitors is less clear, however, and will be the main focus of this article. Here, a firm's basic strategic choice is whether to make its products compatible with those of rivals, thus competing

¹Although this objective is clear enough in an idealized world of single-product firms, it is often complicated in network industries where firms offer several products. A topical example is Microsoft's strategic position as it moves increasingly into the market for PC applications software. Are other applications software firms its partners (in selling Windows and DOS in competition with Unix and other operating systems) or its competitors (in the sale of word processors and spreadsheets)? With vertically integrated firms there is the additional issue of whether to make their components compatible with those of other firms. This "mix and match" issue, which is not considered here, is examined in Matutes and Regibeau (1988), Einhorn (1992), Economides and White (1993), and Farrell, Monroe, and Saloner (1993).

within a standard, or to make them incompatible, resulting in competition *between* standards. Our goal is to illuminate the factors that affect this choice of a horizontal compatibility strategy.

What Network Markets Are Like

Several properties of “network markets”—where users want to buy products compatible with those bought by others—distinguish them from more conventional markets and affect the strategies that firms pursue. First, network markets are “tippy”: the coexistence of incompatible products may be unstable, with a single winning standard dominating the market. The dominance of the VHS videocassette recorder technology and the virtual elimination of its Beta-max rival is a classic case. Another is the choice of an international scientific language, where English is now firmly established.² Moreover, tipping can happen very rapidly. For example, one of the two competing technologies for video encryption of cable television programs completely defeated the other in just a few months of marketplace competition (Besen and Johnson, 1986).

To be sure, tipping can also characterize markets with important economies of scale or learning effects. This similarity is not surprising, since network effects can be described as a demand-side economy of scale. But in network markets it is not the level of current sales, or (as with learning by doing) cumulative sales that determine the winner. Instead, *expectations* about the ultimate size of a network are crucial.

Buyers who join what turns out to be a losing network must either switch, which may be costly, or else content themselves with smaller network externalities than those who associate with the winner. Since buyers’ purchase decisions are therefore strongly influenced by their forecasts of future sales, there can be large rewards to affecting these expectations. In these circumstances, victory need not go to the better or cheaper product: an inferior product may be able to defeat a superior one if it is widely expected to do so (Farrell and Saloner, 1985, 1986; Katz and Shapiro, 1986, 1992; Krugman, 1991). For example, the initial success of MS-DOS is usually attributed not to any technical superiority, but to the fact that it was supported by IBM.

A final characteristic of network markets is that history matters. Outcomes in other markets can often be explained by contemporaneous consumer preferences and producer technologies, but network market equilibria often cannot be understood without knowing the pattern of technology adoption in earlier periods. Because buyers want compatibility with the installed base, better

²Of course, rival standards may coexist if the disadvantages of being on a small network are, for some users, more than offset by a technology’s intrinsic advantages. An example is the continuing role for the Apple computer operating system in a world largely dominated by MS-DOS. As we point out below, however, Apple’s choices are increasingly constrained by the existence of the larger network. See *Apple Computer 1992*, for instance.

products that arrive later may be unable to displace poorer, but earlier standards. A well-known example is the case of the QWERTY typewriter keyboard reported in David (1985).³ In another example, there were significant difficulties involved in convincing enough AM radio users to switch to the superior FM band in the period immediately after World War II (Besen, 1992).

Competition for a Prize

The characteristics of network markets described above mean that competition between incompatible products is not just a matter of slightly better products, or slightly lower costs, and thus slightly higher profits. Rather, small differences, in either perception or reality, can be magnified in a process in which some firms make extremely large gains, and in which dominant market positions are difficult to change. A firm that controls a technology that becomes established as a standard can have an extremely profitable market position, what Ferguson and Morris (1993) call an “architectural franchise.” Examples include IBM’s historical dominance of the mainframe computer industry, and the dominance by Microsoft operating systems and Intel microprocessors in today’s personal computer industry.⁴ When buyers expect network benefits from one firm’s product that other firms cannot provide, a large discrepancy in value is created which the fortunate firm may be able to extract as profit.

Because the prize is so tempting, sponsors may compete fiercely to have their technologies become the standard, and this competition will generally dissipate part—perhaps a large part—of the potential gains. Competition to become the standard may also delay market growth by encouraging buyers to wait to see what the standard will be, that is, what *other* buyers will do. The title of a *Business Week* article in March 1993 told this story: “In Supercomputing, Confusion: A large number of alternative brands and technologies has customers bewildered—and not buying.” Thus, although the prize to the winner is very attractive, the contest itself may not be.

The alternative is that firms standardize, thus explicitly or implicitly agreeing to make their products compatible. Agreeing on a standard may eliminate competition between technologies, but it does not eliminate competition altogether. Instead, it channels it into different and (to economists) more conven-

³For a contrary view of this case, see Liebowitz and Margolis (1990). It is theoretically possible either for movement between standards to happen too slowly or too quickly (Farrell and Saloner, 1985, 1986; Katz and Shapiro, 1986).

⁴As the mention of two firms in one industry indicates, the dominance here is more complex. Microsoft and Intel are each trying to lessen the other’s grip. Microsoft’s new NT operating system reportedly will run on microprocessors other than Intel’s (or clones of Intel’s), while Intel’s newest microprocessors are designed to run operating systems other than Microsoft’s DOS and Windows.

tional dimensions, such as price, service, and product features. A fundamental question for firms facing horizontal competition in a network market, therefore, is whether inter-technology competition to become the standard (competition “for the market”) will be more or less profitable than the ordinary intra-technology competition to be expected (“within the market”) if rivals’ products are compatible. A useful organizing tool for analyzing this decision is the two-by-two matrix of payoffs shown in Figure 1.⁵ Here we depict the technology choices made by two firms, A and B, each of which could, in principle, adopt either technology 1 or technology 2; we assume that the technologies are incompatible. In each cell we indicate the payoff to each firm, so that, for instance, a_{21} denotes firm A’s payoff when it uses technology 2 and firm B uses technology 1.

Where firms are symmetric, these payoffs will depend on two main factors: the skewness of returns and the sharpness of the available competitive tactics in the two forms of competition. The more skewed are the returns, the harder the firms will fight; and the sharper the available tactics the more the fighting will dissipate profits.⁶ Prizes are typically more skewed under inter-technology competition, because the likelihood of tipping gives it an all-or-nothing flavor. By itself, this would tend to make inter-technology competition more vigorous than intra-technology competition, tending to make it dissipate a larger proportion of industry profits. However, because tactics are different in the two forms of competition, industry profits may nevertheless be smaller when there is competition among compatible products. Unbridled price competition with

⁵This looks and feels like a bi-matrix for a game. This intuition is useful if one does not push it too far. As the reader will shortly see, it is not clear whether each of the two moves is available to each player, whether the choices are simultaneous or, if not, who moves first. In describing a game, one requires the specification of all the players’ relevant actions, including seemingly irrelevant ones such as burning money or cheap talk, and the timing and information structure. We most definitely do not do so here. Rather, Figure 1 indicates how payoffs depend on one crucial aspect of players’ choices. As we will see below, many other choices affect these payoffs and enrich the strategic interaction that determines the outcome.

⁶Consider a simplified and abstract competition between two firms in which the winner gets a prize W and the loser gets a prize L . Suppose that each firm can spend resources, including “expenditures” in the form of price reductions, to increase its chance of winning. If firm 1 spends x and firm 2 spends y , firm 1’s chance of winning is $x^a/(x^a + y^a)$, where $a \geq 0$. Firm 1 takes y as given and chooses x to maximize $x^a/(x^a + y^a)W + [1 - (x^a/(x^a + y^a))]L - x$, while of course, firm 2 is making a similar calculation. Solving for the first-order condition and assuming a symmetric equilibrium, we find that $x = y = (a/4)(W - L)$. The two firms’ joint profits are $W + L - (a/2)(W - L)$ and the fraction of potential joint profit $(W + L)$ that is dissipated by competition is $(a/2)(W - L)/(W + L)$. Thus the larger is $(W - L)/(W + L)$, i.e. the more skewed are the rewards, and the larger is a —that is, the more incremental expenditures, including price reductions, increase the chance of winning—the smaller will be actual joint profits. The outcome can be even worse if investments in the standard competition are sequential, and sponsors alternate in making investments. In such cases, the standards battle takes on some of the characteristics of the well-known “auctioning the dollar” game, where there is no limit to the amount that a player will spend to win once he has chosen to play (Shubik, 1971). The fear of this possibility gives firms an additional incentive to avoid a standards battle.

Figure 1

Reduced-form payoff structure from technology adoption

		Firm B	
		Technology 1	Technology 2
Firm A	Technology 1	a_{11}, b_{11}	a_{12}, b_{12}
	Technology 2	a_{21}, b_{21}	a_{22}, b_{22}

compatible products is often extremely effective in shifting market share. For example, although the economic theory is not conclusive, most analysts believe that price competition is more intense when vendor's products are compatible, both because product variety is reduced and because users are less likely to be locked-in to a single firm's product. The recent economics literature on the effects of user lock-in indicates that, in general, lock-in softens competition, even though it also creates strong competition to sign up new users (Beggs and Klemperer, 1992).

There is no general answer to the question of whether firms will prefer competition for the potentially enormous prizes under inter-technology competition, or the more conventional competition that occurs when there are common standards. Indeed, the same firms may choose different strategies in different situations. For example, Phillips and Sony agreed on a compact disk standard and licensed their technology to competitors so as to avoid repeating the VHS/Betamax standards battle, but are now entering just such a contest to determine the new digital audio format (Reilly, 1993).⁷

Forms of Competition

The form of competition will depend on all firm's horizontal compatibility strategies. With just two firms, there are three combinations of such strategies. In the first, all firms prefer to compete to determine the industry standard: we call this situation Tweedledum and Tweedledee. In the second, each firm prefers its own technology as the standard, but each would prefer compatibility with a rival's technology to "going it alone." In this case, the Battle of the Sexes, both firms wish to compete within a standard, but they disagree about what the standard should be.⁸ Finally, one firm may prefer to maintain its technology as a propriety standard while another, whom we call the Pesky Little Brother,

⁷We thank Anita McGahan for this example.

⁸A variant occurs where the firms readily agree on what the standards should be.

may wish to join its rival's network. With more than two firms, competition will involve elements of these three basic forms.

Tweedledum and Tweedledee

If both firms choose incompatibility, then the firms, like Tweedledum and Tweedledee, will agree to have a (standards) battle. In terms of our matrix, this is the case in which the off-diagonal payoffs exceed the on-diagonal ones. This is most likely when the firms are symmetric in their market and technology positions, when the standards battle does not greatly delay the adoption of the technology by consumers, and when intra-technology competition is especially likely to dissipate potential industry profits.

If there is such a standards battle, what will it be like? We identify four tactics of inter-technology competition. This discussion indicates something about what such a battle would be like. Consequently, of course, it is part of the calculus that each firm must make in choosing its horizontal compatibility strategy.

1. *Building an Early Lead.* Recall that network markets tend to display inertia—that is, once a technology is known to have a substantial lead in its installed base, it is difficult for it to be displaced even by a technically superior and cheaper alternative. Consequently, establishing a large installed base quickly and visibly is important.

Because rival firms wish to affect consumers' expectations about the size of their eventual installed base, we might expect especially intense early competition if sales figures are observable to users. In these circumstances, obtaining an early lead may determine the outcome of the race because it may be very difficult for laggards to catch up.

If the installed base is only imperfectly observable to consumers, there is scope for puffery, since appearances may count as much as does reality. Sales figures can be exaggerated in a number of ways—for instance, by counting giveaways and internal users as if they involved sales to customers—and a rival's sales figures can be debunked. This may explain recent behavior by IBM and Microsoft in which each claims wide user adoption of its operating system (OS/2 and Windows, respectively) and denigrates the estimates made by the other (Hamilton, 1992).

An installed base advantage might also be achieved by “penetration pricing,” the technique of offering low prices to early customers so as to build up an installed base and influence the choices of later adopters. Penetration pricing seems a natural strategy in network industries, and appears prominently in the theory (Katz and Shapiro, 1986). Recently, Computer Associates gave away large numbers of copies of its CA Simply Tax and CA Simply Money software, which a financial analyst characterized as “buying their way into the market” (Rosen, 1993).

2. *Attracting the Suppliers of Complements.* A firm always wants complements for its product to be generously supplied, and complements for its rivals'

products to be scarce. Of course, a firm could provide complementary goods itself, but presumably that is costly. An alternative is to affect the choices of suppliers of complements. In particular, those firms will want to supply a large market, so their supply decisions are affected by their expectations about the future size of each network. Influencing the supply of complements is thus an important tool both for establishing a new network technology and for competing against a rival. For example, both IBM and Microsoft have recently attempted to encourage independent developers to write applications software for their operating systems as they compete to make OS/2 or Windows the industry standard. As in the case of the subscriber base, the two firms have made competing claims about the number of applications written for their respective systems (Lindquist and Johnson, 1993).⁹

The absence of support from suppliers of a complement was a serious problem in the case of FM radio, where broadcasters did not develop programming that exploited the medium when it was first introduced (Besen, 1992). In a more recent example, Atari's attempt to introduce its new Jaguar video game system may be stifled by a lack of software.¹⁰ Similarly, Motorola's lack of success in competing with Intel to become an industry standard microprocessor has been attributed to the relative shortage of software written especially for its PowerPC chip (Yamada, 1993b), and Digital Equipment's effort to gain market share has apparently been handicapped by the limited supply of Windows applications compiled for its Alpha chip (Carol, 1993).

A similar problem arose in the introduction of color television. Except for NBC (owned by RCA, then the major supplier of color television receivers), there was little color TV programming in the first decade after the technology was introduced (Ducey and Fratrick, 1989). RCA's use of its ownership of NBC to help establish color TV represents a popular tactic: integrating with the suppliers of complements so as to ensure reliable supply. Sony and Matsushita, supplier of consumer electronic hardware, have recently purchased suppliers of programming, in considerable part to internalize the hardware-software complementarity. Moving this relationship within the firm may accelerate the adoption process (Chandler, 1977). Of course, common ownership may not be crucial: in many cases, explicit alliances and agreements may suffice. But there seems to be a view that leaving the supply of complements completely to "the market" may be unwise.

3. *Product Preannouncements.* A network sponsor may seek to retard the growth of its rivals by choosing to "preannounce" products, so as to discourage users from buying rivals' products prior to the introduction of one's own

⁹Some developers have reacted by using "cross-platform tools" which permit them to write applications for either OS/2 or Windows at little additional cost, so that they are protected whichever system wins the contest, or if both survive (Cunningham, 1992).

¹⁰"Without the software and game titles it's meaningless," according to the editor of an industry newsletter. See "Ailing Atari Pins Hopes on New Video Machines," *San Francisco Chronicle*, August 19, 1993, B1, B4.

(Farrell and Saloner, 1986). The charge that products are preannounced simply to discourage the growth of the installed base of a rival was leveled at IBM in the past and, more recently, it has been directed at Microsoft (Ray, 1992; "Is Microsoft Too Powerful?" *Business Week*, 1993).

Preannouncements can cut both ways, however. A firm that preannounces a better version of its own product risks making buyers wait for that better version, thus shutting off its current cash flow, as happened at Osborne Computer (Osborne and Dvorak, 1984). Thus, firms with little or no current sales may be most tempted to use this tactic; but, for the same reason, claims made by such firms are also likely to have little credibility. It is also interesting to point out that the "Osborne effect" is much more of a threat to hardware firms than to software firms, because the latter can promise cheap upgrades to those who buy their product now, whereas this may be prohibitively costly for hardware vendors.

4. *Price Commitments.* A public commitment to low prices over the long term is another way to convince prospective buyers that they will get large benefits from joining a particular network. Long-term contracts concerning future prices might achieve this, but there may be difficulties in providing such contracts because of uncertainties about costs and problems in providing assurances about quality of next-generation products (Farrell and Shapiro, 1989). However, if costs are observable, a firm with low future costs has an advantage in a standards contest (Katz and Shapiro, 1986).

Future prices might also be signaled in other ways, even perhaps simply by talk. For example, we understand that after the adoption of the NTSC color television standard, RCA announced that its \$1,000 price for a color receiver would drop to \$500 within six months. Although this surely tempted some buyers to wait for the price reduction, especially since there was little programming in color, it might also have had a positive effect, through its effect on viewers' and broadcasters' belief about the long-run size of the "network" of color TV users.

The Battle of the Sexes

If compatibility is overwhelmingly important—so that, for instance, there will be little market demand unless vendors agree on a standard, or if a standards battle will dissipate a large proportion of potential profits—then both firms will prefer intra- to inter-technology competition. Figure 1 then becomes like a coordination game: "both use technology 1" and "both use technology 2" are Pareto efficient and are equilibria. In terms of Figure 1, $a_{11} > a_{21}$ and $a_{22} > a_{12}$ while $b_{11} > b_{12}$ and $b_{22} > b_{21}$. The problem is how to decide between these outcomes.

In some cases the firms will agree on which technology is preferable. The formal standards process is well-adapted to this situation, since it can simply endorse the industry consensus. In other cases, however, both firms want compatibility, but each prefers a different technology, perhaps because it has

developed and “owns” the technology, or because it has advantages over its rivals in using it. Each sponsor wants the other to join its network, but would be willing to join the other’s if the alternative is incompatibility.

In this case, initial tactics must be directed towards persuading the other firm to fight on your turf rather than on his. (Once the turf is chosen, tactics are a matter of how to compete within a standard, about which we have relatively little new to say.) This persuasion game is a bargaining problem, and as in any bargaining problem, tactics may include commitments and concessions. Commitments are actions that visibly reduce a firm’s payoff from agreeing to the Pareto-efficient outcome that it does not prefer, or that increase its payoff when its preferred outcome emerges: for example, building an installed base while engaged in negotiations, or investing in production capacity or in R&D that will not be shared if agreement is reached.

Concessions include not only agreeing to use the other firm’s preferred technology, but also actions that make it more attractive for the other firm to use yours: low-cost licensing, hybrid standards, commitment to join future development, shifting standards development to third parties, and promising timely information to rivals.

If the technologies are “owned” by the respective sponsors, under either patent or copyright law, neither will agree to support the other’s technology as the standard unless it can use it on acceptable terms. Thus, low-cost licensing can help in achieving cooperation.¹¹ Such licensing also provides assurances to buyers that they will have “second sources” (Farrell and Gallini, 1988). A well-known example is Intel’s licensing of its microprocessor designs to AMD.¹²

A second form of concession is to adopt a hybrid standard that combines the technologies of various sponsors. Although combining technologies may exploit the different strengths of the competing standards, it has the additional virtue that it reduces the competitive advantage that would otherwise accrue to a single firm, and thus facilitates agreement. A recent example is the decision by a number of vendors of Unix computer products to develop common standards (Johnson, 1993).¹³ Another example involves the sponsors of competing high definition television (HDTV) systems who recently agreed to merge their technologies and split licensing fees. This was attributed both to a desire

¹¹For more on this view of the role of conflict among vested interests in the formal standards process, see Farrell and Saloner (1988) and Farrell (1993).

¹²Although low-cost licensing is a tactic that sponsors can choose to encourage others to join their network, such licensing is often required when formal standards are adopted. In one case, Unisys and IBM each held patents on technology that was necessary to comply with a proposed compression standard for modems. The two firms reduced their royalty demands substantially when the CCITT, the international telecommunications standards organization, indicated that the level of the royalties jeopardized the acceptance of the standard (Lefton, 1990).

¹³The decision involved concessions by IBM, Hewlett-Packard, Sun Microsystems, Unix System Laboratories, the Santa Cruz Operation, and Univel, and was described as being motivated by “pressure from customers and the threat of a new operating program called NT from Microsoft...” (Zachary, 1993). For a discussion of an earlier agreement by the members of X/OPEN to adopt Unix as a common operating system, see Gabel (1987).

to avoid the costs of subsequent testing before the FCC, which would have reduced the gain to the eventual winner and increased the costs to the losers, and to a fear that the FCC's choice might be challenged in the courts, delaying the introduction of the technology (Carnevale, 1993). Such a challenge was a threat in the case of AM stereo, where the FCC had run a technology competition not very different from the one it employed for HDTV (Besen and Johnson, 1986).

Since the precise characteristics of standard often change through time as technology improves, a commitment to joint future development can be a third type of concession to rivals. This was apparently one of the factors that induced many manufacturers to choose the JVC (Victor Company of Japan) VHS format in preference to Sony's Betamax standard for videocassette recorders (VCRs). Sony apparently believed that the superior picture quality of its Beta technology, together with its strong position in the consumer electronics industry, meant that Beta would eventually dominate the marketplace. As a result, Sony apparently saw less need than did JVC to encourage other firms to employ its technology, assuming that it would eventually reap the benefits of a Betamax standard. In particular, Sony sought to monopolize further product development, while JVC did not, which discouraged other manufacturers from adopting the Betamax standard. Observers of this competition generally attribute the ultimate victory of the VHS standard to JVC's strategy, including sharing future product development, rather than to any inherent superiority of the VHS format (Lardner, 1988; Grindley and McBryde, 1992; Cusumano, Mylonadis, and Rosenbloom, 1991; Morita, 1986).

Still another way for a sponsor to attract rivals to its network is if it agrees to shift future development of the standard to a neutral third party. By doing so, the sponsor assures its rivals that the standard will not be modified to their disadvantage. One motive for the creation of the Open Software Foundation, an industry-sponsored developer of Unix-based software, was to remove control of standard development from any single firm so as to induce others to support the standard (Saloner, 1990; *Sun Microsystems*, Stanford Business School Case S-PD-7). Finally, the support of rivals may be obtained through the promise of timely information about changes in standards, so that they know that they have a chance to adapt their own products to these changes.

Pesky Little Brother

In the "Tweedledum and Tweedledee" case, both sponsors agree to have a battle over a choice between incompatible standards. In the "Battle of the Sexes," both sides agree that competition within a standard is preferable, and the question is whose technology should be the basis of that competition. In both situations, the two firms make the same strategic choices: both want incompatibility or both want compatibility. If firms are symmetric, such a consensus is likely.

When firms are asymmetric, however—in particular, if one firm has a large installed base, a particularly good technology, or a powerful reputation

for setting standards—the dominant firm (say B) is more likely to prefer a standards battle than is a smaller, less established rival (firm A). For example, Katz and Shapiro (1985) show how a larger firm is more likely to prefer incompatibility than a smaller firm.¹⁴ Ferguson and Morris (1993) argue that Asian computer firms are better adapted to intra-technology than to inter-technology competition. Einhorn (1992) and Farrell, Monroe, and Saloner (1993) also discuss how firms' asymmetric strategic positions with respect to quality or cost can lead them to different preferences about compatibility.

This asymmetric situation can be represented in terms of the matrix in Figure 1 as $a_{11} > a_{21}$ and $a_{22} > a_{12}$, but $b_{11} < b_{12}$ and $b_{22} < b_{21}$.¹⁵ The firms' desired strategic "choices" are thus logically inconsistent: one firm wants their products to be compatible and the other does not. As a result, the first exercise of tactics is not a matter of how to play on a particular field, but how to affect the field on which the game is to be played. Subsequent tactics follow, of course, once that conflict is resolved.

The firms' problem is like the game between a big brother who wants to be left alone and a pesky little brother who wants to be with his big brother. In determining the outcome of such a game, timing and commitment issues are critical.

Firm A, like the little brother, wants to "be with," or imitate, firm B. This may be easy if B must commit to its technology and if A can then follow. This is often possible, since B's "dominance" is likely to have been achieved through a history of production and it may be reluctant to abandon its installed base, given the importance of network effects. As a result, B may be powerless to prevent A's following, and the compatibility that A wants will result. In other cases, however, B can resist compatibility in at least two ways: by asserting intellectual property rights, or by changing technologies frequently.

There are many examples of resisting imitation by asserting intellectual property rights. For example, Intel, which has been thriving in inter-technology competition in the microprocessor market, has aggressively enforced its patents in recent generations of its iAPX technology such as the "386" and "486" chips (Slater, 1993). Similarly, Apple used its copyright on its operating system software to prevent the manufacture of an Apple-compatible "clone" in order to deny rivals access to applications software that had been written for its computers.¹⁶ In the computer software and video game

¹⁴ Farrell and Saloner (1992) show that a similar result holds if firms can affect the ease with which "converters" can be supplied.

¹⁵ In the purest form of this case, neither firm cares which technology it uses but only whether or not the technology used by the two firms are compatible: that is, $a_{11} = a_{22} > a_{12} = a_{21}$, and $b_{11} = b_{22} < b_{12} = b_{21}$.

¹⁶ In *Apple Computer, Inc. v. Franklin Computer, Corp.*, 714 F.2d 1240 (3d Cir. 1983), the 3rd Circuit explicitly rejected a "compatibility defense" employed by Franklin. However, in *Computer Associates v. Altai*, 982 F.2d 693 (2nd Cir. 1992), the 2nd Circuit "kept in mind the necessary balance between creative incentive and industrial competition" (p. 696), particularly a compatibility component, and reversed a District Court finding of infringement, leading Philippe Kahn to hail the decision as finding that "compatibility is not a dirty word." "Hurrah for the Second Circuit," *Computerworld*, July 26, 1992, p. 35.

industries, there have been instances in which the owner of a product with a large installed base has tried to use intellectual property rights to limit rivals' access to its standard. These include cases in which software vendors asserted copyright protection not only for their code but also for the "look and feel" of their products.¹⁷ To the extent that this position is sustained by the courts, successful vendors may be able to keep rivals from achieving certain kinds of compatibility.¹⁸

Dominant firms have also tried to prevent compatibility through frequent changes in technology. For example, Crandall (1968) argues that this tactic may have been used by auto producers keen to preserve for themselves the lucrative after-market for replacement parts.¹⁹ It has also been alleged that IBM has used this tactic (Besen and Saloner, 1989), and the settlement of the European Community's antitrust investigation of the company involved IBM's undertaking to abjure this tactic by providing advance information on interface changes. In 1974, Kodak made a similar agreement in settling a private antitrust suit brought by Bell & Howell, which had claimed that Kodak was stifling competition by failing to give sufficient advance notice of new camera/film formats.²⁰ To deal with a similar possibility, Federal Communications Commission rules (47 CFR 64.702), require communications common carriers to provide information about changes in network design and technical standards to rival suppliers of customer-premises equipment and enhanced telecommunications services before the changes are introduced into their networks.

While the leader may try to design its product to make it incompatible with those of its rivals, followers may try to make their products at least partially compatible. For example, because Microsoft has the lead in the number of adopters of Windows over IBM's OS/2 operating system and in the variety of compatible applications programs, IBM has tried to design OS/2 so that it can

¹⁷Ashton-Tate initially tried to prevent the use of its dBase language by other vendors of data base management software (Ryan, 1987). In a series of cases, Lotus was partially successful in using its copyright to prevent other publishers of spreadsheet software from copying parts of the command line structure for 1-2-3. See, e.g., *Lotus Development Corp. v. Paperback Software Intern.*, 740 F.Supp. 37 (D.Mass. 1990). For similar cases involving video games see *Sega Enterprises v. Accolade*, 977 F.2d 1510 (9th Cir. 1992), and (for commentary) "Could ruling effectively outlaw reverse engineering?" *Electronic Business*, August 1992, p. 9.

¹⁸Of course, firms' strategic positions are not immutable. For example, Intel is now attempting to enforce its intellectual property rights aggressively, but had second-sourced the early generations of its microprocessors. When it did not have a clear advantage in inter-technology competition, it was eager to invite rivals such as AMD to compete within rather than against its technology (Zachman, 1990). On the other hand, Apple, which had previously attempted to deny rival computer manufacturers access to software written for its initially very successful operating system, is currently developing software to permit applications programs written for the Macintosh to run on the workstations of other manufacturers (Yamada, 1993a).

¹⁹After about 1970 this tactic became less successful (see e.g., *National Underwriter*, August 21, 1989, pp. 3, 64). Recently, auto producers have argued for intellectual property protection (in the form of U.S. design copyright and GATT provisions) for the design of their parts: see e.g., *National Underwriter*, April 2 1990, p. 36.

²⁰*Chemical Week*, July 17, 1974, p. 24; *Wall Street Journal*, September 18, 1974, p. 29.

run programs written for Windows (Lindquist, 1993). For similar reasons, Sun has announced a new software interface that will permit Windows applications to run on Sun and other Unix workstations (Bozman, 1993).

Conclusion

The process by which standards are established is a rich area of competitive strategy. By promoting standards, or preventing their adoption, firms crucially affect the competitive environment in which they will operate. Firms can expect very large returns if they prevail in a standards battle, but in deciding whether to engage in such battles, each firm must assess the extent to which industry profits will be dissipated by the competitive tactics that are used. Whether a firm tries to establish its technology as a proprietary standard, chooses to join a rival's "network," or offers its technologies to rivals as a proposed industry standard will, therefore, depend not only on its views about how likely it is to prevail in each form of competition but on the nature of the competition itself.

If firms are similar, they will probably choose the same compatibility strategy. If all are willing to offer compatible products, standards are likely to emerge fairly easily. If all want compatibility, but only on their own preferred technologies, each will try to encourage its rivals to join its network. Finally, if all try to establish propriety standards, an all-out standards battle will ensue.

If firms are dissimilar, conflicting strategies are more likely. In particular, newcomers may prefer to join the network of an industry leader while the leader tries to prevent them from doing so. Here, firms do not *choose* how to compete but *fight* over how to compete.

In this paper, we have tried briefly to describe and analyze the determinants of firms' horizontal standards strategies and tactics. We hope that this analysis will help the reader make economic sense of the almost daily news reports of a new standards agreement—or yet another standards impasse.

■ *The authors are grateful to Berkeley undergraduates Patricia Faigao and Alan Ku for research assistance, which was supported under the University's Undergraduate Research Assistant Program, and to Charles Ferguson, Michael L. Katz, Anita M. McGahan, Pierre Regibeau, Carl Shapiro, and Timothy Taylor for very helpful comments on earlier drafts. Farrell also wishes to acknowledge the support of the National Science Foundation under Grant SES 9209509.*

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