Evaluating Appropriability Defenses for the Exclusionary Conduct of Dominant Firms in Innovative Industries

Jonathan B. Baker

September 9, 2014

Abstract

In response to antitrust cases challenging the exclusionary conduct of dominant firms, some dominant firms offer an "appropriability defense": a claim that prohibiting the challenged conduct would harm innovation by lessening the dominant firm's return to investment in research and development (R&D) and, in consequence, undermining that firm's incentive to innovate. This paper explains that an "appropriability defense" should be questioned, and often rejected, if the dominant firm would be expected to increase its own R&D effort in response to increased R&D by its rivals. The paper provides an analytical framework for determining whether a dominant firm would behave this way, based on evaluating the firm's likely incremental gain from new product development if its rivals also introduce new products relative to its gain if its rivals do not upgrade their products. The paper also identifies potentially observable factors relevant to making this assessment. The application of the framework in individual cases is illustrated using the facts of three classic antitrust monopolization cases involving new product development: the *Microsoft* case involving Netscape and Java, the IBM plug compatibility cases (treated as a single case), and the FTC's patent portfolio case against Xerox.

Evaluating Appropriability Defenses for the Exclusionary Conduct of Dominant Firms in Innovative Industries

Jonathan B. Baker*

September 9, 2014

I. Introduction

Patent protection may permit a patent holder to appropriate a larger profit on its innovation. One economic justification is to increase investment in research and development (R&D). A successful innovator with the ability to exclude others from using a patented product or process may earn greater profits, and the anticipation that such profits might be achieved (if the R&D effort succeeds) in turn may increase incentives to invest.

A similar argument sometimes arises in the context of antitrust law. The claim is that R&D investment and innovation would increase if potential innovators were given some ability to exclude competitors, when entry and rivalry from those competitors would reduce the innovator's returns on its innovation. If the innovator were able to appropriate a higher share of the profits on its innovation, the argument goes, it would have greater incentives to invest in R&D. This argument suggests that antitrust law should provide the innovator a type of right to exclude even when it has no such right under patent law. Antitrust law could do so by accepting an "appropriability defense" when exclusionary conduct is challenged under the Sherman Act. Caution in doing is important, however, because an appropriability defense could insulate a wide range of exclusionary conduct from antitrust enforcement, and the costs of erroneously accepting the defense may be substantial.[1]

An appropriability defense has been raised by antitrust defendants in a number of antitrust cases. Microsoft argued on appropriability grounds, in response to the government's monopolization complaint, that the antitrust laws should be construed narrowly. The firm's

* Professor of Law, Washington College of Law, American University. The author is indebted to Rick Brunell, Joseph Drexl, Steve Salop, and Carl Shapiro.

[1] If entrenched business interests – dominant firms, and industry participants acting collectively as though they were a dominant firm – are allowed to employ exclusionary conduct to prevent the introduction of new products, new technologies, and improved ways of doing business, the harm may go beyond the fortunes of individual industries and their customers to threaten economic development and economic growth. *See generally* Jonathan B. Baker, *Exclusion as a Core Competition Concern*, 78 ANTITRUST L.J. 527, 559-60 (2013).

economic expert contended, among other things, that any relief that would reduce the profits to successful software development would harm competition and consumers by lessening the incentive of Microsoft and other firms to develop new and better software.[2] Intel provides another example. In defending against the Federal Trade Commission's wide-ranging exclusionary conduct case settled by consent in 2010, that firm expressed concern that the relief contemplated by the FTC would discourage product improvements by restricting the way that it designed new products and exercised its intellectual property rights.[3]

The Supreme Court explicitly rejected the appropriability defense proffered in *Kodak*.[4] Kodak had appealed to appropriability as a type of free rider rationale for refusing to sell parts to the independent service organizations (ISOs). As Justice Blackmun explained for the Court,

> Kodak claims that its policies prevent ISO's from "exploit[ing] the investment Kodak has made in product development, manufacturing and equipment sales in order to take away Kodak's service revenues." Kodak does not dispute that respondents invest substantially in the service market, with training of repair workers and investment in parts inventory. Instead, according to Kodak, the ISO's are free-riding because they have failed to enter the equipment and parts markets. This understanding of free-riding has no support in our case law. To the contrary, as the Court of Appeals noted, one of the evils proscribed by the antitrust laws is the creation of entry barriers to potential competitors by requiring them to enter two markets simultaneously.[5]

By contrast, Justice Scalia's opinion in *Trinko* cited appropriability as the reason that anticompetitive conduct is included as an element of the monopolization offense, and as a basis for questioning whether a unilateral refusal to deal would satisfy that element.

> The opportunity to charge monopoly prices–at least for a short period–is what attracts "business acumen" in the first place; it induces risk taking that

[2] The expert "maintained [that] relief against Microsoft should be rejected because it amounts to a penalty for successful firms, which threatens to retard investment in the personal computer software industry, 'with devastating long-run consequences to consumers and the U.S. economy.'" Richard M. Brunell, *Appropriability in Antitrust: How Much is Enough?* 69 ANTITRUST L.J. 1, 28 (2001) (quoting Richard L. Schmalensee, Direct Testimony ¶623, United States v. Microsoft, No. 98-1232 (D.D.C. 2000)).

[3] Answer of Respondent Intel Corp. at 5, In the Matter of Intel Corp., No. 9341 (F.T.C. Dec. 31, 2009) ("The relief contemplated by the Complaint would require Intel to delay or even forego product improvements unless it could simultaneously ensure that such improvements equally benefited Intel competitors, essentially requiring Intel to design its products for the benefit of its competitors rather than for its own benefit and the benefit of consumers."), *id.* at 8 (The complaint "seek[s] to strip Intel of intellectual property rights earned by Intel over many years of dedicated research and enormous investment.").

[4] Eastman Kodak Co. v. Image Technical Services, Inc., 504 U.S. 451 (1992).

[5] 504 U.S. at 485 (citation omitted and footnote omitted).

> produces innovation and economic growth. To safeguard the incentive to innovate, the possession of monopoly power will not be found unlawful unless it is accompanied by an element of anticompetitive *conduct*. … Firms may acquire monopoly power by establishing an infrastructure that renders them uniquely suited to serve their customers. Compelling such firms to share the source of their advantage is in some tension with the underlying purpose of antitrust law, since it may lessen the incentive for the monopolist, the rival, or both to invest in those economically beneficial facilities. [6]

Justice Blackman in *Kodak* expressed concern that exclusionary conduct would reduce the incentives of rivals to invest. Justice Scalia in *Trinko* suggested that freedom to exercise monopoly power would increase the investment incentives of both the dominant firm and its rivals. These contrasting views raise several related economic questions about the consequences of permitting a dominant firm to exclude its rivals. First, will a dominant firm's exclusionary conduct raise or lower the R&D investment of its rivals? Second, assuming that it reduces competitors' investment, will it raise or lower the investment of the dominant firm? Third, assuming that it raises the investment of the dominant firm, will total investment increase or decrease, and will consumer welfare rise or fall?

The economic literature focuses on the second question, and provides two main reasons to expect that exclusionary conduct that enhances the appropriability of the dominant firm would *not* lead to increased innovation incentives overall.[7] One is the empirical economics literature that shows the importance of product market competition for fostering innovation.[8] Another is

[6] Verizon Commc'ns Inc. v. Law Office of Curtis V. Trinko, 540 U.S. 398, 407-08 (2004) (dicta) (emphasis in original). To similar effect, the Second Circuit resisted finding liability in two well-known decisions when doing so would force dominant firms to pre-disclose product improvements to rivals or otherwise share the financial rewards to innovation, in part on the ground that such relief would undermine dominant firm incentives to invest in R&D and develop new products. Berkey Photo, Inc. v. Eastman Kodak Co., 603 F.2d 263, 284-85 (2d Cir. 1979) (deeming it impossible to find Kodak liable for failing to take corrective action on its own for unadjudicated prior offenses, concluding that a continuing predisclosure requirement would confer benefits on rivals disproportionate to the competitive harms, and cautioning against a decree that might stifle future innovation); SCM Corp. v. Xerox Corp., 463 F. Supp. 983, 1001 (D. Conn. 1978), *remanded*, 599 F.2d 32 (2d Cir. 1979) (seeking to avoid construing the antitrust laws to require sharing with competitors the financial rewards to innovation, as doing so could harm investment incentives and "risk inhibiting the commercialization of patented inventions to an extent inconsistent with the purposes of the patent laws.").

[7] These are not the only reasons that exclusionary conduct may reduce overall prospects for innovation. *See generally* Richard M. Brunell, *Appropriability in Antitrust: How Much is Enough?* 69 ANTITRUST L.J. 1, 29-36, 37 (2001) (discussing six counterarguments to the incentive argument for a permissive antitrust regime). *Cf.* Marina Lao, *Ideology Matters in the Antitrust Debate*, 79 ANTITRUST L.J. 649, 661-62 (2014) (setting forth reasons why the imposition of a unilateral duty on a monopolist to deal with its rivals could enhance or reduce industry innovation).

[8] *See generally* Jonathan B. Baker, *Beyond Schumpeter vs. Arrow: How Antitrust Fosters Innovation*, 74 ANTITRUST LAW JOURNAL 575, 583-86 (2007); Carl Shapiro, *Competition and Innovation: Did Arrow Hit the Bull's Eye?*, *in*

the observation that in many markets the dominant firm's payoff to innovation, and thus its incentives to invest in R&D, would likely remain high even if its exclusionary conduct is prohibited, because of structural features like rapid market growth, scale economies, network effects, sale of complementary products, and high customer switching costs.[9] This paper offers an additional explanation for the empirical result that competition increases investment incentives, and an additional reason to question a dominant firm's appropriability defense, based on the impact of investment by rivals on the investment incentives of the dominant firm.

Dominant firm conduct excluding rivals from a product market[10] affects the dominant firm's incentives to invest in R&D through two routes, one direct and one indirect. The direct route is emphasized by the appropriability story: putting aside influences arising from the way the firms interact, exclusionary conduct would be expected to increase the dominant firm's payoff to innovation and reduce the payoff to rivals, boosting dominant firm R&D investment and chilling rival R&D investment. The dominant firm's appropriability defense treats this dynamic as the primary influence on incentives to innovate, and tells the same story in reverse: it argues that

---

THE RATE AND DIRECTION OF INVENTIVE ACTIVITY REVISITED 361, 376-82 (Josh Lerner & Scott Stern eds.) (2012). *See also* John T. Scott & Troy J. Scott, *Innovation Rivalry: Theory and Empirics*, 41 ECONOMIA E POLITICA INDUSTRIALE 25 (2014).

The Schumpeterian growth literature does not bear directly on the consequences for overall industry innovation of the types of dominant firm exclusionary conduct considered in this paper. That literature concludes that greater product market competition fosters R&D investment by all firms in sectors where the firms operate at the same technological level, Philippe Aghion, Stefan Bechtold, Lea Cassar & Holger Herz, The Causal Effects of Competition on Innovation: Experimental Evidence 2, 10 (NBER Working Paper No. 19987, 2014), and suggests that in the event that product markets were to grow more competitive, the innovation incentives of a dominant firm with a technological lead would remain high. Philippe Aghion, Ufuk Akcigit & Peter Howitt , What Do We Learn From Schumpeterian Growth Theory? 13-14 (NBER Working Paper No. 18824, 2013) (Prediction 2 & Figure 2) (greater product market competition in markets with a technological leader mainly operates to discourage R&D investment by laggards until they have caught up). Carl Shapiro emphasizes that this literature models increased product market competition as arising from greater imitation (hence reduced appropriability for entrants) rather than from increased contestability (hence increased appropriability for entrants). Shapiro, *Competition and Innovation* at 372-74. The antitrust interventions considered in this paper would increase entrant appropriability, consistent with the latter perspective.

[9] Brunell, 69 ANTITRUST L.J. at 32 (attributing this observation to Timothy Bresnahan in the policy discussion of the Microsoft litigation). *See also* Jonathan B. Baker, *Beyond Schumpeter vs. Arrow: How Antitrust Fosters Innovation*, 74 ANTITRUST L.J.575, 593-98 (2007); Jonathan B. Baker, Exclusionary Conduct When R&D Investment in New Products is Strategic 10 & 10 n. 15 (Working Paper 2014).

[10] This paper is concerned with exclusion from product markets, not with dominant firm conduct that raises the costs of rival R&D, although the conditions that would suggest questioning a dominant firm's appropriability defense for product market exclusion would also suggest questioning such a defense if offered to justify conduct raising rivals' R&D costs. *See* Jonathan B. Baker, Exclusionary Conduct When R&D Investment in New Products is Strategic 26-27 (Working Paper 2014).

antitrust enforcement limiting exclusionary conduct would lessen dominant firm investment in R&D even as it encourages rivals to invest. This paper emphasizes a second route, based on the likelihood that the dominant firm's incentives to invest in R&D also depend on the R&D investments of its rivals. That influence could, in principle go in either direction: greater rival investment could lead the dominant firm to invest either more or less than it would invest if only the direct route mattered. The dominant firm's response to the innovative effort of its competitors may be substantial even if the rivals are not characterized as disruptive entrants or mavericks, and even if the rivals employ the same technology and business model as the dominant firm.

Considering only the direct effect, antitrust enforcement against exclusionary conduct would be expected to reduce dominant firm R&D and increase rival R&D. But if the dominant firm would respond to greater rival R&D by increasing its own R&D investments, then the indirect and direct forces would influence dominant firm R&D investment in opposing directions. If the indirect force is more important, the appropriability dynamic would be completely reversed: the dominant firm will respond to antitrust enforcement by increasing its R&D investment. Even if the direct route is the more important influence on dominant firm R&D, an indirect force working in the opposite direction would weaken the appropriability dynamic, making it more likely that after also accounting for rival R&D, industry investment incentives will increase overall.[11]

For this reason, a dominant firm's appropriability defense should be questioned, and often rejected, if exclusionary conduct lessens rival R&D investment and the dominant firm would be expected to increase its own R&D effort in response to increased R&D by its rivals. Then greater product market competition, the product of antitrust enforcement, would enhance innovation incentives by spurring R&D competition. Although this condition may seem difficult to assess empirically with the evidence available in individual cases,[12] the paper identifies factors relevant to making such judgments and illustrates their application. Section II sets forth an analytical framework for evaluating whether the dominant firm would be expected to increase its own R&D effort in response to increased R&D by its rivals. In Section III, the facts of well-known monopolization cases against Microsoft, IBM and Xerox are used to

[11] Analogous direct and indirect forces also influence rival investment incentives. Although this paper emphasizes the forces affecting dominant firm incentives, a full analysis would consider both firms. *See generally* Jonathan B. Baker, Exclusionary Conduct When R&D Investment in New Products is Strategic (Working Paper 2014).

[12] *Cf.* Brunell, 69 ANTITRUST L.J. at 4-6, 37-38 (emphasizing difficulty of determining whether to prefer appropriability arguments or competition counterarguments in general or on a case-by-case basis); Lao, 79 ANTITRUST L.J. at 661 ("It is difficult to predict reliably the incentive and net innovation effects of antitrust enforcement against dominant firm conduct.").

illustrate how the framework can be applied to determine whether to question or accept a dominant firm's appropriability defense.

II. Evaluating an Appropriability Defense

To frame the analysis, consider the following hypothetical situation. Suppose that a dominant firm and a smaller rival compete in selling the first generation of a product, and that both are also competing to develop next-generation products.[13] Suppose further than the dominant firm can take steps to exclude its rival from the post-innovation product market and that the antitrust laws would permit such exclusion. To keep the analysis simple, assume that the exclusionary conduct would not also affect pre-innovation product market competition. It is reasonable in practice to focus solely on post-innovation exclusion when evaluating the appropriability defense because the dominant firm would not proffer that defense unless it is concerned with the incentive consequences of post-innovation product market competition.[14]

[13] In the case examples discussed in Section III, the firms are competing to develop new products. *Cf.* F.M. Scherer, *The Theory of Market Structure and Innovation, in* F.M. SCHERER, INNOVATION AND GROWTH: SCHUMPETERIAN PERSPECTIVES 59 (1986) (viewing "most industrial R&D [as] product oriented" rather than cost-saving process R&D). The primary model in the related economic theory paper is concerned with new product development. Jonathan B. Baker, Exclusionary Conduct When R&D Investment in New Products is Strategic (Working Paper 2014).

[14] The effect of exclusionary conduct on dominant firm innovation incentives may depend on whether the dominant firm excludes its rival from pre-innovation competition or post-innovation competition, because the direct effects would be expected to go in opposite directions: pre-innovation exclusion would reduce the dominant firm's incentive to innovate in order to escape competition, while post-innovation exclusion would enhance the dominant firm's appropriability incentive to innovate. *See generally* Jonathan B. Baker, Exclusionary Conduct When R&D Investment in New Products is Strategic (Working Paper 2014). When exclusionary conduct would affect both pre-innovation and post-innovation competition, the dominant firm's innovation incentive would likely depend primarily on post-innovation consequences, the concern in this paper, as the present value of dominant firm profits in product markets after new products are introduced would commonly be expected to exceed its profits while R&D is underway but before the products are introduced.

This generalization is not inconsistent with the successive innovation model of Segal and Whinston. Ilya Segal & Michael Whinston, *Antitrust in Innovative Industries*, 97 AM. ECON. REV. 1703 (2007). In that model, successful entrants displace incumbents but then become subject to the possibility of displacement by future entrants. Segal and Whinston find that antitrust enforcement prohibiting exclusionary conduct increases the present value of entrant profits from R&D, leads the entrant to increase its R&D investment, and raises the probability of entrant innovation success, when it increases the profits an entrant earns before it is displaced by more than it reduces the discounted future profits an entrant earns after it is displaced. The profits an entrant earns before it is displaced may be understood as the innovator's post-innovation profits, and the profits it earns after it is displaced include the possibility of profiting through future re-entry, and thus may be viewed as future pre-innovation profits. *See also* Joshua S. Gans, *When is Static Analysis a Sufficient Proxy for Dynamic Considerations? Reconsidering Antitrust and Innovation, in* 11 INNOVATION POLICY AND THE ECONOMY 55, 63 (Josh Lerner & Scott Stern, eds.

In this situation, exclusionary conduct by the dominant firm would be expected to discourage R&D and innovation by the dominant firm's rivals.[15] At the same time, the conduct would be expected to increase the return to dominant firm innovation. The appropriability defense points to the latter consequence as an incentive for increased dominant firm R&D investment and faster dominant firm innovation. Yet whether or not industry-wide innovation would benefit from the exclusionary conduct depends on comparing the social benefit of encouraging R&D investment by the dominant firm R&D with the relative social harm of discouraging rival R&D investment.[16]

For the same reason, whether or not industry-wide innovation would benefit from an antitrust *prohibition* on the exclusionary conduct depends on comparing the social benefit of encouraging rival R&D investment with the social harm of discouraging R&D investment by the dominant firm. The indirect effect of the dominant firm's response to rival R&D investment could limit the harm side of that balance. If that indirect effect is sufficiently strong, moreover, an antitrust prohibition could even encourage both firms to increase their R&D investment, and necessarily increase the likelihood of industry innovation.[17]

The above analysis of the overall consequence of exclusionary conduct for innovation turns on the possibility that the dominant firm would respond to increased rival R&D investment by increasing its own R&D investment – that is, on whether the dominant firm regards rival R&D as what economists term a "strategic complement." If so, and if the strategic complementarity is sufficiently powerful, antitrust intervention to prevent exclusionary conduct by a dominant firm would be expected to encourage industry innovation on balance, to the benefit of consumers.[18] Under such circumstances, the dominant firm's appropriability defense should be rejected.[19]

2011) (Segal & Whinston's model implies that the rate of entrant innovation increases by an antitrust prohibition on any incumbent practice "whose profitability is dependent on a reduction in entrant innovation").

[15] Although the exclusionary conduct would likely also discourage price competition, this paper focuses primarily on its consequences for innovation.

[16] Social welfare effects would also depend on the consequences of the conduct for price competition.

[17] This outcome would also require that direct effect of the antitrust prohibition on rival R&D investment dominate in the rival's decision-making, so that rival R&D investment continues to increase.

[18] Jonathan B. Baker, Exclusionary Conduct When R&D Investment in New Products is Strategic 22 (Working Paper 2014) (Proposition 8, Corollary 2).

[19] Moreover, even if the dominant firm's response is not sufficiently powerful for industry innovation incentives to increase overall, that response may mean that there is little innovation cost to antitrust intervention. Then any net innovation benefit of increased appropriability may be more than offset by the harm to consumers from the loss in product competition arising from the exclusionary conduct, as when that conduct permits the dominant firm to maintain its market power.

Although a dominant firm's response to rivals' conduct can be difficult to anticipate, economic theory suggests an approach to doing so with respect to R&D investment.[20] That approach is based on comparing the payoffs the dominant firm receives in various states of the world, where the states are defined by whether or not the dominant firm or its rivals successfully innovate. In particular, the dominant firm will treat rival R&D investment directed toward new products as a strategic complement when the incremental benefit of innovation to the dominant firm is greater when rival innovation succeeds than when it fails.[21]

The relationship between the dominant firm's response to rival R&D investment and the returns it expects to receive in various states of the world may make it possible to infer the nature of the strategic interaction in R&D competition from potentially observable aspects of market structure. Most importantly, as shown in the example set forth as an appendix to this paper, a dominant firm is more likely to treat rival R&D as a strategic complement when (a) the dominant firm anticipates that it would have a high market share when both it and its rival successfully innovate, and when (b) the dominant firm anticipates that it would lose a great deal of business to its rival if the rivals innovate and it does not. Each of these factors tends to increase the dominant firm's incremental gains from developing a next-generation product when its rivals introduce an upgrade – one by raising the benefits of dominant firm innovation when rivals also innovate, and the other by raising the cost to the dominant firm of not matching rival innovation. Hence each tends to increase the dominant firm's incremental benefit from new product introduction given that its rival also does so, relative to the firm's incremental benefit when its rivals do not upgrade.

The example in the appendix also identifies a third factor relevant to determining whether the dominant firm will regard rival R&D as a strategic complement. It shows that when a new product introduction is expected to increase the sales of complementary products, and those sales would be very profitable (as when the dominant firm is the only seller of the complementary goods), the dominant firm may gain more from new product introduction when it is the only firm to do so than if others upgrade as well. Under such conditions, the dominant firm cares mainly about ensuring that *some* firm introduce a new product, so its incremental gain from upgrading

[20] Jonathan B. Baker, Exclusionary Conduct When R&D Investment in New Products is Strategic (Working Paper 2014). Outside the framework of that paper, suppose that firms can finance R&D less expensively out of retained earnings than external finance, perhaps because of information asymmetries between innovators and investors or lenders. Then, one might imagine that exclusionary conduct by an innovator would simultaneously reduce rival R&D investment and raise the innovator's R&D investment. In this dynamic, the innovator would behave as though its rival's R&D is a strategic substitute. This capital markets imperfection is more likely to matter to an entrant or fringe rival than to the large and established dominant firms in the case examples considered below, however, so will not be considered further in this paper.

[21] Jonathan B. Baker, Exclusionary Conduct When R&D Investment in New Products is Strategic 14 (Working Paper 2014) (Proposition 3).

its own product conditional on its rival introducing a new product will be small. In consequence, the dominant firm will no longer treat rival R&D as a strategic complement.[22] The case analyses in the next section illustrate how to analyze these three factors – the dominant firm's likely market share when both firms innovate, the dominant firm's likely customer loss if a rival upgrades when it does not, and the impact of innovation on the dominant firm's profits in the sale of complementary products – to identify the likely response of dominant firms to increased R&D investment by a rival and evaluate whether to question an appropriability justification for the dominant firm's exclusionary conduct.

III. Three Classic Monopolization Cases

This section turns to three classic antitrust monopolization cases involving the development of new products – the *Microsoft* case involving Netscape and Java, the IBM plug compatibility cases (which are treated as a single case), and the FTC's patent portfolio case against Xerox. Those cases are used to illustrate how the factors set forth in Section II can be employed to analyze the dominant firm's likely response to rival investment in R&D. The discussion of the monopolization cases does not evaluate whether an appropriability defense should or should not have applied, but instead demonstrates the workability of the analytical framework by illustrating how the issue would be approached on the facts of each. Although the cases involve a diverse set of competitive effects theories, they do not address the full range of exclusionary conduct that a dominant firm could seek to justify by relying on an appropriability defense.

A. Microsoft (Netscape and Java)

In 2001, the D.C. Circuit upheld a district court decision finding that Microsoft, the dominant firm in personal computer operating systems, unlawfully maintained its monopoly power through exclusionary conduct.[23] That conduct impeded the success of two firms developing new products in complementary markets: Netscape, which was developing a browser, and Sun Microsystems, which was developing the Java programming language. These products had the potential to allow applications programs written for Microsoft's operating system to run on rival operating systems as well, thereby making rival operating systems better substitutes for Microsoft's Windows and enhancing operating system competition with Windows.

[22] The example in the appendix also shows that if the new product introduction is anticipated to represent a drastic improvement over current generation products, that the dominant firm would also no longer treat rival R&D as a strategic complement.

[23] United States v. Microsoft Corp., 253 F.3d 34 (D.C. Cir. 2001) (en banc).

Netscape was impeded through exclusivity agreements and other conduct that limited Netscape's access to key channels of product distribution.[24] Sun was impeded through exclusivity agreements and other conduct that favored the distribution of Java with modifications created by Microsoft that would prevent software applications from working on personal computers that used Sun's Java.[25] In the jargon of the case, Netscape and Sun's new products had the potential to erode the "applications barrier to entry" that limited the competitive prospects of Microsoft's operating systems rivals.[26] By excluding these suppliers of third products, Microsoft forestalled the development of key building blocks that rival operating systems could use when developing next generation operating system products to make them compete better with Microsoft's Windows operating system product.[27] In consequence, the prospects for future innovation and price competition in operating systems were reduced.[28]

Microsoft's economic expert defended the firm's practices in part on appropriability grounds, as protecting the incentives of software firms, including Microsoft, to develop new and better software products.[29] As applied to Microsoft itself, this justification may be evaluated by analyzing how that firm would likely respond to increased innovative effort by its rivals or, more precisely in this case, to increased innovative effort by firms selling complements when

[24] *Microsoft*, 25 F. 3d at 59-74. The other exclusionary practices including integrating Microsoft's Internet Explorer browser into that firm's Windows operating system. According to a statement attributed to Microsoft, Microsoft intended to "cut off Netscape's air supply." John Schwartz, *Government, Microsoft Present Contrary Views of Trial*, WASHINGTON POST, Aug. 11, 1999, at E3.

[25] *Microsoft*, 25 F. 3d at 74-77. The other exclusionary practices included deceiving Java developers about the Windows-specific nature of the tools Microsoft distributed to them, and coercing Intel to stop aiding Sun in improving Java technologies. One Microsoft document described the firm's conduct as aimed at increasing the market for "polluted" Java. *Id.* at 77.

[26] *See Microsoft*, 253 F.3d at 55 (defining "applications barrier to entry").

[27] Together, Netscape's browser and Java had the potential to allow applications programs to access application programming interfaces, thereby allowing applications programs to run on any operating system supporting the browser and Java and, in consequence, eroding the applications barrier to entry that was protecting Windows from competition from rival operating systems. *See Microsoft*, 25 F. 3d at 53 -56.

[28] The monopolization allegations – the primary focus of the litigation and the opinions of the district and appeals courts – focused on competitive harms in an operating system market. The public debate over Microsoft's conduct also concerned possible competitive harms in a browser market.

[29] *See* Richard M. Brunell, *Appropriability in Antitrust: How Much is Enough?* 69 ANTITRUST L.J. 1, 28 (2001) (discussing testimony of Microsoft's economic expert, Richard Schmalensee). In addition, Microsoft's "freedom to innovate" public relations effort – advocacy outside the courtroom – could be understood as resting implicitly on an appropriability justification. *E.g., Ads in Newspapers Take Microsoft's Case to Its Users*, SEATTLE TIMES, Apr. 9, 1998, http://community.seattletimes.nwsource.com/archive/?date=19980409&slug=2744284.

improvements to complementary products would increase the ability of rival operating systems to compete with Windows.[30] If Microsoft would be led to increase its own innovative efforts, its response would tend to undermine Microsoft's appropriability justification for its exclusionary conduct.

Testimony by Microsoft's economic expert, interpreted through the lens of the analytical framework set forth in Section II above, raises the possibility that Microsoft would have behaved this way. According to that testimony, with software generally, and, presumably, operating systems in particular, customers make investments predicated on their existing software. As a result, rivals cannot succeed when introducing new products if their products are no better than those of incumbent market leaders.[31] Hence Microsoft would likely have anticipated maintaining a high market share if it and its operating system rivals both introduced upgrades, even if the applications barrier to entry were reduced through antitrust enforcement.

Microsoft's expert also testified that entrants can win in software markets – operating system markets included[32] – by introducing new products that represent substantial improvements,[33] and thereby displace current market leaders.[34] If so, an operating system rival would be expected to take a great deal of business from Microsoft by introducing a next-generation operating system when Microsoft did not.[35]

These two factors – Microsoft's likely high market share when it and rivals both innovate, and Microsoft's likely anticipation of substantial customer loss if a rival upgrades when

[30] The discussion here presumes that operating systems rivals that foresaw the prospect that the applications barrier to entry would be reduced and their ability to compete with Windows increase would have an incentive to invest more in developing improvements to their own operating systems.

[31] *See* Richard L. Schmalensee, Direct Testimony ¶38, United States v. Microsoft, No. 98-1232 (D.D.C. 2000) ("Competitors cannot win by introducing a trivial advance over existing leaders" in the microcomputer software industry "because that would require asking consumers to scrap investments in their current software for minimal gain"). *See also id.* at ¶34 (consumers "stay with the current leader until a product comes along that is sufficiently superior to warrant abandoning their investments in the leader"). The testimony was couched in terms of software generally, but it is evident that it was intended to apply to operating systems software in particular.

[32] *See id.* at ¶38 ("[e]ntry and success in computer operating systems appears harder than for most microcomputer software categories" but it is "eminently feasible").

[33] *See id.* at ¶38 ("firms try to win by 'leapfrogging' the existing leader with substantial improvements").

[34] *See id.* at ¶¶ 33-37.

[35] This aspect of the expert's testimony was offered in support of the expert's claim, contested by the government and rejected by the courts, that entry was easy in operating systems notwithstanding the challenged practices. But the implication highlighted here, about the likely success of a new operating system introduced by a rival and not matched by Microsoft in the event the applications barrier were reduced, would have been less controversial.

Microsoft does not – suggest that Microsoft would to benefit more by improving Windows if its rivals improved their own operating systems than if its rivals stood pat.[36] If the exclusionary conduct were prohibited, and Microsoft's operating system rivals took advantage of the erosion of the applications barrier to entry to introduce upgraded operating systems, therefore, Microsoft would be expected to respond with an increased effort of its own. This expected response would call into question Microsoft claim, based on the appropriability logic, that antitrust enforcement would lessen its incentive to innovate.[37]

B. IBM (Plug Compatibility)

The IBM plug compatibility cases involved competition in computer peripherals.[38] During the late 1960s and early 1970s, IBM was the leading manufacturer of central processing units (CPUs) for general purpose computers, and likely accounted for the majority of shipments.[39] In addition, IBM, along with multiple rivals, sold peripheral equipment (tapes,

[36] The third factor identified in Section II, Microsoft's profits from the sale of complementary products, seems unlikely to influence that firm's response to rival R&D in operating systems. To conclude otherwise, one would need to suppose that operating system improvements would substantially increase the sales of Microsoft's applications programs, such as its Office suite.

[37] Given the steps Microsoft took to integrate its browser into Windows, Microsoft may have viewed improvements in browsers as innovation in operating systems. If so, the browser feature competition between Microsoft's Internet Explorer and the rival Firebox browser during the mid-2000's can be understood as consistent with the view that Microsoft would treat rival operating system R&D as a strategic complement. *See, e.g.*, Erik Larkin, *Radically New IE 7 or Updated Mozilla Firefox 2 – Which Browser is Better?* PCWORLD (Oct. 24, 2006), http://www.pcworld.com/article/127309/article.html.

[38] Transamerica Computer Co. v. International Business Machines Corp., 698 F.2d 1377, 1383-84 (9th Cir. 1983); California Computer Products, Inc. v. International Business Machines, 613 F.2d 727, 744 (9th Cir. 1979); Telex Corp. v. International Business Machines, 510 F.2d 894 (10th Cir. 1975).

[39] IBM's share of general purpose computers (the market in the cases most closely related to CPUs) was estimated at 57% in one case. In re IBM Peripheral EDP Devices Antitrust Litigation, 481 F. Supp. 965, 981-82 (N.D. Cal. 1979) (accepting a 57% share for the 1969 through 1975 period), *aff'd*, Transamerica Computer Co. v. International Business Machines Corp., 698 F.2d 1377, 1381, 1382 (9th Cir. 1983). In another case, witnesses for plaintiff asserted that IBM's market share in general purpose computers was between 60% and 80% for unspecified years, likely the early 1970s, although IBM questioned those figures. California Computer Products, Inc. v. International Business Machines, 613 F.2d 727, 738-39 (9th Cir. 1979). A third district court cited internal IBM documents as estimating that firm's share of CPUs at 64% in 1968 and cited the U.S. Bureau of the Census as estimating that in 1971 IBM accounted for 41% of the value of shipments of "Electronic Computers, Digital, General Purpose" (not the same as CPUs, but the closest analogue in the census data referenced). Telex. Corp. v. International Business Machines Corp., 367 F. Supp. 258, 285-86 (N.D. Okla. 1973), *rev'd,* Telex Corp. v. International Business Machines, 510 F.2d 894 (10th Cir. 1975). The appellate panel reviewing that decision characterized the district court as estimating IBM's market share at 35%, apparently referring to a revenue share figure the district court cited for electronic data processing as a whole rather than specifically for CPUs. Telex, 510 F.2d at 899.

disks, printers and terminals) that worked with IBM's computers. IBM may have had a monopoly share in markets for plug-compatible peripherals during the early 1970s.[40]

When IBM introduced a new generation computer system in the early 1970s, it changed the way peripheral equipment was connected. Its new CPUs were incompatible with the peripherals that worked with its prior generation computers and compatible only with new peripheral products sold only by IBM. Several rival manufacturers of plug-compatible peripherals challenged this conduct as monopolization.[41] In resolving this aspect of the cases, the courts implicitly accepted an appropriability justification for some of IBM's conduct: they declined to condemn IBM's product design decisions found to enhance product quality or reduced manufacturing costs,[42] in part in order to avoid chilling that firm's incentives to innovate.[43]

To illustrate how an appropriability defense could have been evaluated in this setting using the framework set forth in Section II, the discussion will focus on IBM's incentives to develop next-generation peripherals, the markets that were allegedly monopolized through exclusionary conduct.[44] If IBM would respond to greater innovative effort by its rivals in peripherals by increasing its own innovative efforts, its response would have tended to undermine an appropriability justification for IBM's exclusionary conduct.

IBM would likely respond in this way if it would expect to benefit more by developing next generation peripherals in the event its rivals also introduced upgraded peripheral products than

[40] Telex. Corp. v. International Business Machines Corp., 367 F. Supp. 258, 288-90 (N.D. Okla. 1973), *rev'd,* Telex Corp. v. International Business Machines, 510 F.2d 894 (10th Cir. 1975); In re IBM Peripheral EDP Devices Antitrust Litigation, 481 F. Supp. 965, 986-87 (N.D. Cal. 1979) (average market share of 54% for one peripheral product and 77% for another between 1969 and 1975), *aff'd*, Transamerica Computer Co. v. International Business Machines Corp., 698 F.2d 1377 (9th Cir. 1983) *see* California Computer Products, Inc. v. International Business Machines, 613 F.2d 727, 738-39 (9th Cir. 1979) (plaintiff offered evidence that IBM's markets share in peripherals fell from 79% to 68% from 1970 to 1972; IBM's evidence was that its share was less than 30%). .

[41] Plaintiffs also unsuccessfully alleged that price cuts by IBM on older peripherals amounted to predatory pricing.

[42] California Computer Products, Inc. v. International Business Machines, 613 F.2d 727, 744 (9th Cir. 1979); IBM Peripheral EDP Devices Antitrust Litigation, 481 F. Supp. 965, 1002-03, 1007-08 (N.D. Cal. 1979), *aff'd*, Transamerica Computer Co. v. International Business Machines Corp., 698 F.2d 1377, 1383-84 (9th Cir. 1983).

[43] An appropriate legal standard for design conduct "must properly balance a concern for the preservation of desirable incentives with the need to prevent monopolization by technology". IBM Peripheral EDP Devices Antitrust Litigation, 481 F. Supp. 965, 1003 (N.D. Cal. 1979) , *aff'd*, Transamerica Computer Co. v. International Business Machines Corp., 698 F.2d 1377, 1383-84 (9th Cir. 1983). "Truly new and innovative products are to be encouraged …." *Id.*

[44] IBM could also have argued that relief that would limit its ability to profit in the sale of peripherals could chill its incentives to develop improved computer CPUs, a complementary product. That claim would require separate analysis.

by upgrading if its rivals did not innovate. The discussion in Section II suggests that whether this condition holds would depend in part on IBM's expected market share if all firms introduced new products, IBM's expected customer loss if only its rivals upgraded, and the consequences of new peripherals for the demand for computer systems, a complementary product also sold by IBM.

Based on the description of the industry in the court opinions, it seems possible that IBM would have anticipated maintaining a high market share in peripherals if, absent the challenged incompatibility, both it and rivals had introduced next-generation products. Factors like customer loyalty, brand reputation, and service would likely have protected IBM's share,[45] although the fact that its share in current generation peripherals had been declining would have cut the other way.[46] That share decline, in a market in which both IBM and rivals introduced new products, also suggests that rivals would have taken substantial peripheral business away from IBM by upgrading peripherals if IBM did not also do so.

These two factors together suggest that IBM could have benefitted substantially by upgrading peripherals in the event its rivals also did so. By innovating, IBM may have been able to avoid the costly outcome in which only its rivals introduced new products, and IBM could have earned substantial profits in the event both it and its rivals upgraded. The difference in profitability between those outcomes could well have exceeded the incremental gain to IBM from introducing new peripherals in the event it was the only firm to do so. If so, IBM would likely have responded to greater innovative effort by its peripherals rivals – as might have been the product of antitrust enforcement against IBM's conduct – by increasing its own innovative effort, contrary to what an appropriability defense would suppose.

This conclusion could be overturned by considering the consequences of the development of next generation peripherals for the sale of computer central processing units, a complementary product in which IBM likely had a high share. If new peripheral products made a substantial difference to computer sales, and computer sales were more profitable to IBM than peripheral equipment sales, then IBM would have benefitted from the introduction of new peripherals regardless of whether the new products came from IBM or its rivals. That could mean that the incremental benefit to IBM from innovating in peripherals would have been greater if rivals did not innovate than if they did. Upgrading its peripherals when rivals did not would have boosted IBM's computer demand, while upgrading its peripherals when rivals introduced new products would not add much to computer demand (which would already have gone up with the peripheral introductions of IBM's rivals). If the profitability of complementary products was the

[45] IBM maintained a high market share in peripherals for years after rivals developed peripherals compatible with IBM's new generation computer.

[46] The parties disagreed over the speed and extent of the share decline.

dominant influence on IBM's response to rival innovative effort, then IBM might have responded to antitrust enforcement by cutting back on its own effort, consistent with what an appropriability defense would maintain.

C. Xerox (Patent Portfolio)

In 1975, the Federal Trade Commission and Xerox – then the dominant firm in plain paper copying – agreed to settle by consent an FTC case concerned largely with Xerox's accumulation of patents.[47] The FTC's chief economist at the time later explained that the case centered on "the extension over time of [Xerox's] monopoly through patent accumulation."[48] The FTC was concerned that that Xerox's extensive patent portfolio discouraged competition.[49]

[47] Decision & Order, Xerox Corp., Docket No. 8909, *reprinted in* Xerox Corp., 86 F.T.C. 364, 369-86 (1975). *See generally* Willard K. Tom, *The 1975* Xerox *Consent Decree: Alien Artifacts and Current Tensions*, 68 ANTITRUST L. J. 967 (2000). The FTC's complaint also challenged marketed practices for products covered by the patents.

[48] *Roundtable Discussion on Competition Policy, Intellectual Property and Innovation Markets, in* ROBERT D. ANDERSON & NANCY T. GALLLINI, COMPETITION POLICY AND INTELLECTUAL PROPERTY RIGHTS IN THE KNOWLEDGE-BASED ECONOMY 447, 449 (1998) (remarks of Professor F.M. Scherer).

[49] Patent aggregation could inhibit price competition in product markets. It also could discourage innovation by a dominant firm's rivals, and thus potentially reduce innovation overall, for multiple reasons. *Cf.* BRONWYN. H. HALL, CHRISTIAN HELMERS, GEORG VON GRAEVENITZ, CHIARA ROSAZZA-BONDIBENE, A STUDY OF PATENT THICKETS (2013) (empirical study concluding that patent thickets in a technological area discouraged entry into that sector). First, patent aggregation may discourage rivals from challenging weak patents by making it more difficult for rivals to prove that a dominant firm's patents are invalid or narrow in scope. *See* United States v. Singer Mfg. Co, 374 U.S. 174 (1963) (dominant firm's control of multiple patents increased its likelihood of success in proving patent infringement by an importer with rapidly-increasing U.S. sales); *id.* at 177 n.2, 180, 190 (dominant firm acquisition of control over multiple patents reduced the likelihood that those patents would have their claims narrowed or collectively be declared invalid); *id.* at 198-99 (White, J., concurring) (patent cross-licenses and acquisitions lessened the likelihood that a potential rival or court would uncover information about the nature and scope of prior art). Second, a dominant firm's patent aggregation may discourage rival innovative effort by making it more costly for a rival to review and analyze its likelihood of prevailing in infringement litigation brought by the patent portfolio owner. David L. Schwartz, On Mass Patent Aggregators, 114 COLUM. L.REV. SIDEBAR 51, 64 (2014) (discussing the "numerosity problem"). Aggregation raises rivals' costs because it requires rivals to analyze many patents in response to an infringement claim. In addition, the aggregation of multiple weak patents may increase the likelihood that *some* patent in the collection would be found valid and broad in scope, thereby increasing the likelihood that the portfolio owner would assert infringement. Third, when a dominant firm acquires weak patents, those transactions may shift ownership to a firm more likely to enforce the patents against product market rivals, given the dominant firm's ability to profit through product sales as well as through royalties. *Cf.* Mark A. Lemley & Carl Shapiro, *Probabilistic Patents*, 19 J. ECON. PERSPECTIVES 75, 85, 88-90 (2005) (small product market rivals may have suboptimal incentives to challenge patents asserted against them). The government has challenged acquisitions in part for this reason. Complaint, Decision & Order, and Aid to Public Comment, Amgen Inc. & Immunex Corp., FTC Docket No. C-4056, 5-6 (Sept. 6, 2002) (preventing a combination of patent portfolios that threatened to allow the merged firm to block future product market sales of IL-1 inhibitors by the only other firm developing a competing pharmaceutical product); *see* Final Judgment, United States v. Borland Int'l, Inc., 1992-1 Trade Cas.

Under the settlement, Xerox agreed to license its patents for a small royalty. That remedy appears to have spurred R&D investment and entry by new rivals,[50] and to have woken up a lethargic monopolist, which then invested more as well.[51] Firm conduct after entry of the consent order thus suggest that Xerox responded to increased rival investment in new product development by increasing its own innovative effort.[52] These industry outcomes offer an after-the-fact reason to question an appropriability justification for Xerox for that firm's accumulation of patents.

The framework set forth in this paper illustrates how an appropriability defense could have been evaluated as of the time of the settlement. If Xerox would have been expected to respond to rival innovation by increasing its own innovative efforts, its response would have tended to undermine an appropriability justification for Xerox's assembly of a patent portfolio.

Xerox may reasonably have anticipated that if it and its rivals both introduced new products, Xerox would be able to maintain a high market share. Xerox likely had a strong brand reputation, an extensive sales and service network, and perhaps an installed base dominated by customers that had made investments in learning how to use its products, so it may have

---

(CCH) 69,774 (N.D. Cal. 1992) (preventing an acquisition of a dominant firm by its leading rival, under circumstances in which the dominant firm did not enforce uncertain copyright rights against a third firm but the merged firm would likely have done so). *See also* Competitive Impact Statement, United States v. Borland Int'l, Inc., 56 Fed. Reg. 56,096, 56,100 (1991); Catherine Fazio & Scott Stern, *Innovation Incentives, Compatibility, and Expropriation as an Antitrust Remedy: The Legacy of the Borland/Ashton-Tate Consent Decree*, 68 ANTITRUST L. J. 45 (2000).

[50] *Cf.* Worldwide Copier Strategy 12 (Harvard Business School Case 9-384-151, 1988) (describing Canon's R&D investment and patenting strategy during the late 1970s and early 1980s); *id.* at 14 (Canon's goal as of 1983 was summed up in the slogan "Catch Xerox through technological differentiation"); *id.* at 15 (Exhibit 1) (listing 17 new plain paper copier models introduced by Canon in the U.S. between September1972 and April 1983).

[51] Willard K. Tom, *The 1975* Xerox *Consent Decree: Alien Artifacts and Current Tensions*, 68 ANTITRUST L. J. 967, 968, 979-79 (2000). *Cf.* Timothy F. Bresnahan, Post-Entry Competition in the Plain Paper Copier Market, 75 AM. ECON. REV. 15, 18 n3 (Papers & Proceedings, 1985) (deeming it hard to tell whether greater competition or new technological opportunities from the invention of microprocessors better explains the rapid increase in industry innovative activity); *id.* at 18 (after losing its monopoly, Xerox shifted from innovations in the copier to innovations in user interfaces, perhaps reflecting competitive pressure to develop improvements with more commercial interest than engineering interest).

[52] Xerox may have viewed its rivals' *products* (as opposed to rivals' investment in R&D) as strategic substitutes, however. Timothy F. Bresnahan, Post-Entry Competition in the Plain Paper Copier Market, 75 AM. ECON. REV. 15, 17 (Papers & Proceedings, 1985).

expected any erosion in its market share would be slow.[53] Such a prediction would have proven incorrect, as rivals successfully challenged Xerox's leading position during the years following the settlement. But this outcome appears to have resulted mainly from the unanticipated entry of Japanese firms rather than anticipated entry by IBM and Kodak,[54] so it could have been sensible at the time for Xerox to forecast that it would keep a high market share. Xerox may also have anticipated that its advantages with customers would not have been sufficient to protect it from losing market share rapidly in the event rivals with strong reputations, like IBM and Kodak, introduced next-generation product but it did not.[55]

If these suppositions about Xerox's view of the consequences of new product development are correct, than Xerox would have expected a substantial incremental benefit from upgrading its own copier products in the event rivals entered with new products. By developing a next-generation copier, Xerox would avoid a substantial customer loss, and preserve a high market share. Under such circumstances, the incremental benefit to Xerox of introducing a next-generation product would likely have been greater in the event rivals introduced new products than if rivals did not,[56] so Xerox would have been expected to increase its innovative effort in response to a greater innovative effort by rivals. Such an anticipated response would provide reason to question an appropriability justification for Xerox's patent accumulation.

IV. Conclusion

This paper has explained that a dominant firm's appropriability defense for exclusionary conduct should be questioned, and often rejected, if the firm would be expected to increase its

[53] *See* Canon Inc.: Worldwide Copier Strategy 6 (Harvard Business School Case 9-384-151, 1988) (in 1983, Canon had more than 600 U.S. dealers, for which it provided extensive financing and training in sales and service); *id.* at 8-9 (describing Canon's brand advertising in the U.S. from 1978 to 1982).

[54] The FTC's chief economist at the time indicated that he expected IBM and Kodak to introduce copiers, but did not anticipate the smaller and more reliable products introduced by Japanese firms. *Roundtable Discussion on Competition Policy, Intellectual Property and Innovation Markets, in* ROBERT D. ANDERSON & NANCY T. GALLLINI, COMPETITION POLICY AND INTELLECTUAL PROPERTY RIGHTS IN THE KNOWLEDGE-BASED ECONOMY 447, 448 (1998) (remarks of Professor F.M. Scherer). By the early 1990s, Canon and Sharp both sold more copiers in the U.S. than Xerox, and Canon had a larger installed base. William R. Boulton,The Plain Paper Copier Industry 8 (Auburn Univ.1995), www.auburn.edu/~boultwr/copiers.pdf.

[55] *Cf.* Timothy F. Bresnahan, Post-Entry Competition in the Plain Paper Copier Market, 75 AM. ECON. REV. 15 16-17 (Papers & Proceedings, 1985) (entrants obtained a high share of new placements during the years in which Xerox did not compete with them on price).

[56] Copier firms sold complementary products, mainly toner and paper, but most of their revenues came from copiers and multiple firms produced complements, so it is unlikely that the sale of complements influenced Xerox's strategic response to rival R&D in copiers. *See* Canon Inc.: Worldwide Copier Strategy 5 (Harvard Business School Case 9-384-151, 1988) (describing Canon's business in copier consumables and accessories as of 1983).

own R&D effort in response to increased R&D by its rivals. Whether a dominant firm would behave this way can be evaluated by analyzing its likely incremental gain from new product development if its rivals also introduce new products, relative to its gain if its rivals do not upgrade their products. Three examples from historical monopolization cases involving new product development illustrate the application of this analytical framework to evaluate an appropriability defense in individual cases.

As a group, the case examples suggest that it would neither be unusual nor surprising for dominant firms to respond to new product development efforts of rivals with greater innovative effort of their own. The latter observation supports other reasons in the economic literature for skepticism about relying on an appropriability justification as a basis for framing antitrust rules or developing enforcement policy regarding dominant firms.[57]

[57] The other reasons are sketched *supra* at text accompanying notes 7-9.

Appendix

Economic Factors Influencing a Dominant Firm's Strategic Response to Rival R&D Investments

This appendix draws upon the results in the related economic theory paper to identify factors affecting whether a dominant firm would increase its R&D investment in new product development in response to greater R&D investment by its rivals.[58] The related paper shows that the direction of the dominant firm's response depends on whether it gains more from innovation in the event other firms innovate too, relative to how much it would gain in the event that others do not innovate.

That comparison depends upon the dominant firm's likely payoffs to innovation in four states of the world:[59] its payoff from developing a new or next-generation product in the event its rivals also do so (Π^{ss}), its payoff from developing a new or next-generation product if it is the only firm to do so (Π^{sf}), its payoff in the event its rivals develop a new or next-generation product and it does not (Π^{fs}), and its payoff in the event no firm succeeds in developing new or next-generation products (Π^{ff}). The related paper shows that the dominant firm has an incentive to increase its R&D investment in response to an increase in R&D investment by its rival if the dominant firm's incremental gain from innovation success in the event its rivals also succeed ($\Pi^{ss} - \Pi^{fs}$) exceeds the dominant firm's incremental gain from innovation success when its rivals do not innovate ($\Pi^{sf} - \Pi^{ff}$), or when $\Delta = [(\Pi^{ss} - \Pi^{fs}) - (\Pi^{sf} - \Pi^{ff})] > 0$.

The expression Δ represents the incremental benefit of innovation success to the dominant firm conditional on rival success, net of the incremental benefit of innovation success conditional on rivals not innovating. The magnitude of the dominant firm's R&D response to rival R&D investment (the slope of its reaction function) is an increasing function of Δ.[60] The example in this appendix identifies economic factors that affect the size of these payoffs, and thus the relative magnitudes of the two incremental gains and the sign of Δ.[61]

---

[58] Jonathan B. Baker, Exclusionary Conduct When R&D Investment in New Products is Strategic (Working Paper 2014).

[59] In the notation, the first superscript indicates whether the dominant firm's innovative effort succeeds (s) or fails (f), and the second superscript indicates whether its rivals succeed or fail.

[60] This is implied by equation (3) in Jonathan B. Baker, Exclusionary Conduct When R&D Investment in New Products is Strategic 14 (Working Paper 2014). (The dominant firm's best response function defined there, where it is denoted R^1, expresses rival R&D investment as a function of dominant firm investment. The reaction function relevant here is the inverse: one in which the dominant firm's R&D investment is expressed as a function of rival R&D investment. Equation (3) in that paper implies that $d(R^1)^{-1}/d\Delta > 0$.)

[61] It is termed an example rather than a model because it does not indicate how prices, industry output, or market shares are determined. Moreover, in the states of the world in which the dominant firm successfully innovates, the part of the dominant firm's payoff that would come from profits on sales made before the new product is made

Suppose that two firms, a dominant firm and a rival, participate in a market. If neither firm innovates, both firms charge price P^0, the industry collectively sells output Q^0,[62] the dominant firm's pre-innovation market share is S^0, and the dominant firm's marginal cost is C. Then, $\Pi^{ff} = (P^0 - C)S^0Q^0$. If either firm succeeds in developing the new product, the market price rises to P^1 (with $P^1 \geq P^0$) and industry output increases to Q^1 (with $Q^1 \geq Q^0$). If the rival does not succeed, the dominant firm captures the entire market, so $\Pi^{sf} = (P^1 - C)Q^1$. If the rival also succeeds, the dominant firm's anticipated post-innovation market share is S^1 (with $0 \leq S^0 \leq S^1 \leq 1$), so $\Pi^{ss} = (P^1 - C)S^1Q^1$. Finally, if the rival succeeds but the dominant firm does not, the dominant firm cannot charge more and it loses Q^d customers to its rival (with $Q^d \leq SQ^0$). The rival may not gain the entire market because the rival's new product may not be enough better to overcome customer switching costs or factors like brand loyalty that may protect the dominant firm's market share from complete erosion. Hence, $\Pi^{fs} = (P^0 - C)(S^0Q^0 - Q^d)$. The four payoff terms are best viewed as present discounted values of a stream of future profits.[63]

In this example, Δ becomes

$$(1)\ \Delta = [(\Pi^{ss} - \Pi^{fs}) - (\Pi^{sf} - \Pi^{ff})]$$

$$= [(P^1 - C)S^1Q^1 - (P^0 - C)(S^0Q^0 - Q^d)] - [(P^1 - C)Q^1 - (P^0 - C)S^0Q^0]$$

$$= (P^0 - C)Q^d - (1\text{-}S^1)\,(P^1 - C)Q^1.$$

Equation (1) is intended to provide intuition about the factors influencing Δ, not a formula that would be calculated when evaluating the likely nature of dominant firm conduct in individual cases.

The dominant firm regards its rival's R&D investment as a strategic complement if Δ is positive ($\Delta > 0$), and as a strategic substitute if Δ is negative ($\Delta < 0$). In equation (1), the sign is determined by the relative size of the two (positively-signed) terms in the final line: $(P^0 - C)Q^d$ and $(1\text{-}S^1)\,(P^1 - C)Q^1$. Those two terms represent profits captured from the dominant firm by its

---

available is ignored. Similarly, if the dominant firm does not innovate but its rival does, the dominant firm's profits arising from sales made before the rival makes its new product available are ignored.

[62] The quantity sold in this and other states of the world may be thought of as cumulative over the life of the product, with discounting ignored (or discounted under the assumption that prices increase over time at the dominant firm's discount rate).

[63] This point may be important, for example, in evaluating forgone profit terms in industries in which rivals have been gaining share in the pre-innovation setting and may be expected to garner an increasing share over time in the event all firms innovate.

rivals in different states of the world. The expression $(P^0 - C)Q^d$ accounts for the reduced contribution to dominant firm profits from sales lost to rivals in the event that rivals innovate and the dominant firm does not, relative to what the dominant firm would earn if neither it nor its rivals innovate. The second term, $(1\text{-}S^1)\ (P^1 - C)Q^1$, reflects the lost contribution to dominant firm profits from sales lost to rivals in the event both it and its rivals innovate, relative to what the dominant firm would earn if only it innovates.

Equation (1) shows that Δ is an increasing function of both S^1 and Q^d. A high anticipated market share for the dominant firm in the post-innovation product market in the event the dominant firm and its rival both introduce new products (a high S^1) raises Δ by increasing the dominant firm's incremental benefit of innovation success when its rival also succeeds (that is, by increasing Π^{ss}). A substantial loss of customers from the dominant firm to its rival in the event that the rival develops a new or next-generation product while the dominant does not (a high Q^d) raises Δ by increasing the incremental payoff to the dominant firm from innovating when its rival succeeds (that is, by reducing Π^{fs}), because it reduces the dominant firm's payoff when its rival succeeds and the dominant firm does not. Thus, increases in both S^1 and Q^d raise the dominant firm's incremental gain from innovation success in the event its rivals also succeed $(\Pi^{ss} - \Pi^{fs})$.

Equation (1) also indicates that the greater magnitude of the innovation – the more the new product expands the market (higher Q^1) and the greater the value the new product offers customers (and thus the higher the post-innovation markup $(P^1 - C)$) – the less likely the dominant firm is to regard its rival's R&D investment as a strategic complement. The more that the new product represents a major improvement over existing generation products, the more that the incremental benefit of innovating in the event its rival also innovates will be dominated by the dominant firm's payoff when both succeed (Π^{ss}), and the more that its incremental benefit in the event the rival does not innovate will be dominated by its payoff when only it succeeds (Π^{sf}). Of the two, the latter payoff is greater because the dominant firm captures the market when it is the only successful innovator, while it is limited to the fraction S^1 when both firms succeed. In the limit as the innovation grows drastic, therefore, Π^{sf} will control the sign of Δ, which will be negative.

The extent to which the dominant firm's increased profits from the sale of complements matters depends on the nature and extent of competition in complementary products markets. At one extreme, if the dominant firm is the only seller of the complementary products, it may be reasonable to suppose that it will earn the same additional contribution to profit in complementary goods markets when a new product is introduced, regardless of whether it, its

rival, or both successfully innovate.[64] Adding this feature to the example lowers Δ relative to the expression set forth in equation (1). If Φ represents the total incremental profits available from the sale of complementary products resulting from the introduction of a new product, and the dominant firm expects to capture them regardless of which firm innovates, then $\Delta^* = \{[(\Pi^{ss} + \Phi) - (\Pi^{fs} + \Phi)] - [(\Pi^{sf} + \Phi) - \Pi^{ff}]\} = \Delta - \Phi < \Delta$. For Φ sufficiently large, $\Delta^* < 0$, implying that the dominant firm treats rival R&D as a strategic substitute regardless of the sign of Δ. Thus, if the dominant firm's profits from the introduction of a next-generation primary product mainly derive from the profits it receives through increased sale of complements, then the dominant firm gains a great deal from introducing an upgraded primary product when its rival does not but gains little from developing its own new product when its rival has done so. Under such circumstances, the dominant firm would be expected to respond to a reduction in rival R&D by increasing its own R&D investments and respond to an increase in rival R&D by reducing its own investments.

The above analysis of the role of complementary goods depends critically on the assumptions that overall profits are dominated by profits in the sale of complementary products and that the dominant firm is the only seller of complementary products. If instead the dominant firm and its rival both sell complementary products, and the dominant firm earns additional profits from the sale of complementary products following the introduction of the new product only if it sells the new product, then Δ would still be lower than the expression set forth in equation (1) – but not by much if the dominant firm's anticipated market share is large. In particular, if the dominant firm's share of the incremental profits available from the sale of complementary products depends on its share of sales of new products, then $\Delta^{**} = \{[(\Pi^{ss} + S^1\Phi) - \Pi^{fs}] - [(\Pi^{sf} + \Phi) - \Pi^{ff}]\} = \Delta - \Phi(1-S^1)$, which approaches Δ as S^1 approaches one. Moreover, and at the other extreme, if multiple firms sell the complementary product, and the dominant firm would not expect to make many incremental sales or would expect earn only a small margin on any incremental sales it does make, then the sale of complements would make little difference to Δ and, in consequence, not affect the dominant firm's R&D investment decisions.

Equation (1) also shows that a high dominant firm profit margin pre-innovation (a lower C, holding P^0 constant) tends to lead the dominant firm to see its rival's R&D investment as a strategic complement if the dominant firm's anticipated market share is high. The main reason is that in the example, a high pre-innovation margin tends to mean that post-innovation margins

[64] But perhaps not. If rivals innovate but the dominant firm does not, and if most of the dominant firm's customers switch to products sold by rivals, the strategic interaction between the two firms selling complementary products – one a sole seller (the dominant firm in the complementary product) and the other nearly so (the rival in the primary product) – would affect the margin the dominant firm receives on the complementary product. In particular, if the two firms treat their products as Cournot complements, the margin on the primary product could rise. Alternatively, and to similar effect, if primary market competition between the dominant firm and its rival remains important, the dominant firm could increase the margin on the complementary product in order to soften primary market rivalry.

will be even higher, increasing the dominant firm's incremental benefits of innovation success when its rival also succeeds (by increasing Π^{ss}). But a higher margin also affects the dominant firm's payoffs in the other three states of the world, generating incentives that go in the opposite direction. In the example, the latter incentives would dominate if the dominant firm's anticipated market share is sufficiently small.[65] However, the above interpretation of the significance of a high pre-innovation profit margin turns on a special feature of the example: the assumption that when both firms participate in the market (both succeed or both fail), they charge an identical price. For this reason, and because of well-known difficulties of measuring marginal cost, the discussion in the text does not discuss the dominant firm's pre-innovation price-cost margin when analyzing the case examples.

[65] That is, $d\Delta/dC < 0$ if and only if $(Q^d/Q^1) + S^1 > 1$, which is satisfied only if S^1 is sufficiently high.