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ANTITRUST POLICY AND HIGH-TECHNOLOGY INDUSTRIES

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1. Introduction[1]

Does antitrust policy[2] promote economic growth and international competitiveness by stimulating investment in the creation of knowledge? Or, on the contrary, is antitrust policy a regressive force that shackles entrepreneurial spirit and creates disincentives for invention and innovation? Can antitrust as a policy, which in the United States is now celebrating its one hundredth anniversary, be safely applied to today's high–technology industries? Should those European policy makers who wish to extend antitrust policy restrain their zeal,[3] especially now that the countries of the European Community (EC) are experiencing a prolonged economic slump and their industries are hard pressed by competitive forces emanating not only from the US and Japan but also from newly industrialized countries?[4] What are the dangers of uncoordinated, domestic antitrust policies for home firms in high–technology industries when these firms must compete in global markets against foreign rivals that are not subject to the same restraints on their conduct?[5]

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[1]We should like to thank Carl Shapiro for extensive and most helpful comments, Ken Rogoza for research assistance, Alannah Orrison for editorial help, and the C. V. Starr Center for Applied Economics at New York University for financial assistance. We apologize to all those whose ideas have been embodied in our paper without full citations.

[2]Antitrust policy is part and parcel of competiton policy, at least as the latter term is used in Europe. See, e.g., Swann [1983] for a comprehensive discussion of competition policy in the European Community. It will be clear, however, that our discussion covers only a small range of the policies that come within the purview of competition policy.

[3]See B. Hawk [1986] for an extensive review of developments in antitrust policies in the EC and the member countries.

[4]See Fitoussi and Phelps [1988].

[5]It is unlikely that Japan will develop serious antitrust policies in the near future. Consequently, it can be taken as given that the US and the EC countries will continue competing with Japanese firms that will not be subject to antitrust enforcement in their home market. In the export markets, the conduct of these firms will come under the purview of the relevant antitrust laws. See, e.g., Matsushita [1978]. For a very brief survey of the Japanese approach to antitrust see Baumol and Ordover [1985].

We do not claim that we have complete answers to these basic questions. Rather, we believe that we can offer an outline of a reasonably well unified approach that can be used to probe the issues just raised. This unified approach rests on two basic building blocks. The first is the recognition that in high–technology, highly innovative industries the key market asset possessed by any firm is knowledge. Knowledge (information) is quite unlike any other productive asset because of its public goods character, with all the well known problems of such goods. Low diffusion costs for the knowledge asset suggest that public policy should encourage its widespread use, and hence suggest that there should be a minimal amount of property right in the asset. But if the owner of the knowledge asset has only minimal property rights, she may not be able to appropriate the initial investment costs. As a result, the initial investment may not be undertaken. This argues for public policies that make exclusion cheap, to the detriment of diffusion.[6]

This conflict between diffusion and appropriability–cum–exclusion is frequently regarded as the trade–off between static and dynamic efficiency in public policy. From that vantage point, antitrust policy is taken to be directed toward the static concerns while protection of intellectual property through patent, copyright, trademark, and other policies is viewed as a reflection of broader social concerns for long–run growth and technological progress. While there is some truth to this characterization, the magnitude of the conflict can easily be exaggerated.[7] Indeed, it seems to us that, at least in the US, antitrust policies are evolving in a direction that minimizes the conflict. Such a trend is evidenced by the National Cooperative Research Act of 1984,

[6]This distinction between diffusion and exclusion is best illustrated with an example. The incremental cost of providing a television signal to a household is nil, meaning that diffusion costs are low. The cost of excluding a household from receiving a signal can be high or low depending on the costs of the exclusion technology, such as scramblers.
[7]See Kaplow [1984] and Ordover [1984] for an assessment of the alleged policy conflict.

in the more relaxed treatment of vertical restraints (hence licensing agreements), and in the more relaxed merger enforcement policies. On the other hand, where conflict remains it is our general inclination to resolve it in favor of long–run dynamic considerations. This is due to the fact that, within bounds, we wish to encourage the supply of innovations.[8] We regard static welfare losses to be outweighed by dynamic welfare gains from technological progress and new product introductions.

In the next section, we analyze how a single firm can use its technological edge to obtain and maintain market leadership. We consider whether or not antitrust polices should restrain leading firms in their use of technology as a competitive weapon against smaller rival firms. We conclude that antitrust has some, albeit a very limited, role in ensuring that technological advantages are not abused.

Sections 3 through 5 deal with cooperation among potential rivals in the production and diffusion of knowledge. We begin by examining patent licensing agreements, move on to research joint ventures, and then consider mergers among firms in high–technology industries. Our key policy conclusion is that antitrust laws should be applied sparingly to cooperative arrangements –– including mergers –– that are likely to stimulate the production and diffusion of knowledge. The main reason for our conclusion is that if R&D activities of firms aare uncoordinated, they may fail to provide the socially optimal amount of investment in the production of knowledge. Coordination in the use of assets among rival firms may be necessary to correct market failures in the production and distribution of knowledge. Further, we believe that strong entrepreneurial goals will keep in check the anticompetitive forces that may come into play, especially in the early stages of development of a high–technology industry.

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[8]See Baumol and Ordover [1988] for an elaboration of this point.

2. The Economics of Market Dominance: Entrepreneurship and Technological Innovation

All too often, antitrust analyses of the economics of market dominance have relied heavily on a static framework in which the leading incumbent firm maintains its market position by a variety of "standard" predatory practices,[9] such as predatory pricing, for example. In industries in which technological progress is rapid and entrepreneurial efforts focus on product and process innovation, static analyses of market dominance are potentially irrelevant and also are misleading.

Static analyses are irrelevant for all industries in which market dominance cannot be easily acquired and maintained through such standard means as predatory pricing or advertising.[10] In such industries, market leadership demands "skill, foresight, and industry," as reflected in a continuous commitment to expenditures on new technologies and products. Such expenditures are, on the whole, in the social interest and represent a socially desirable investment in the acquisition and maintenance of market leadership.[11]

The standard analyses are likely to be misleading because for several reasons they tend to overestimate the importance of diffused market power for long-run economic efficiency. First, it is obvious that a firm that has succeeded in a technological race is likely to obtain a dominant position in the relevant product market, and that often this dominant position is transitory. Nonetheless, even transitory market dominance provides the firm with the opportunity to recoup its sunk

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[9]See Ordover and Saloner [1988] for an extensive discussion of various predatory strategies and for an extensive bibilography on the subject.
[10]See Hay and Vickers [1987], p. 4, Table 1.1, for a summary of strategies for the exercise, acquisition, and maintenance of market dominance.
[11]See Fudenberg and Tirole [1987] for examples of models in which investments in the creation of market power are not socially wasteful.

expenditures on R&D.[12] From the social standpoint, pricing above non–sunk cost in this process can plainly be efficient.[13]

Second, and more important, diffusion of market power is not necessarily the state of affairs most conducive to the kind of sustained investment in R&D that leads to product and process innovations. This argument centers on appropriability of knowledge –– insofar as a firm with a dominant market share can better protect the fruits of its innovation against imitation, product market dominance stimulates investment in R&D by reducing the gap between private and social returns to innovation. Schumpeter's view that monopoly stimulates rather than retards technological progress is not supported by careful econometric and statistical studies.[14] Nevertheless, evidence strongly indicates that concentration is not inimical to innovation, at least up to some threshold level. Consequently, antitrust intervention that attempts to diminish the market power of dominant firms may weaken future incentives for innovation without necessarily providing offsetting gains in current market efficiency.

Third, static analyses of market power are apt to be misleading because they tend to focus on market dominance at the downstream (product) level. This focus of concern can well miss the point. In high–technology industries, there is surely a strong presumption that the initial locus of interest should be on the upstream (R&D) stage. The issue of focus creates methodological difficulties relating to the definition definition and of R&D markets and measurement of concentration in those markets. We skirt around these problems here and mention them only briefly in sections 4 and 5.

This is not to say that we would condone all those activities of innovating firms that increase profits while substantially increasing short–run allocative inefficiency.

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[12]Patent licensing offers another alternative, as we shall discuss below.
[13]When there are scale economies in production, marginal cost pricing is not feasible without subsidies (which have their own distortions attached to them). See Brown and Sibley [1986] on Ramsey pricing.
[14]Baldwin and Scott [1987] review the pertinent empirical literature.

We agree that an innovator may "abuse" a patent, for example by using it as a fulcrum for tacit collusion in the downstream market.

In sum, for the economics of single–firm market dominance in high–technology industries, the relevant lines of inquiry would appear to be upon the following questions: (a) Does the dominant firm in the product market also currently dominate the R&D stage? If it does, how likely is it that such dominance will persist? (b) Does product–market dominance serve to perpetuate dominance in the R&D stage? (c) Given that lowering entry barriers into the R&D stage tends to improve short–run and long–run efficiency, are there significant entry barriers into the relevant R&D stage, and can those barriers be raised strategically by the dominant firm? And, (d), given the answers to questions (a) – (c), what trade–offs will antitrust intervention entail if incremental improvements in the current diffusion of the existing stock of knowledge alter the incentives for future investments in R&D? That is, if antitrust policy has the effect of improving access to the existing stock of knowledge, will it, by the same token, weaken entrepreneurial incentives to add to the future stock of knowledge?

Broadly speaking, one can divide a dominant firm's strategies into those that are in the main predatory, and into those that are preemptive or exclusionary. By predatory strategies, we mean those designed to induce the exit of a smaller but not necessarily technologically less capable rival; by preemptive or exclusionary ones, we mean those that are designed to forestall entry or to dissuade an existing rival from enlarging its market share. Obviously, as any business strategist would note, predatory and exclusionary strategies are frequently intertwined. But what is more important is that in dynamic, technology–driven industries in which entrepreneurial spirit has not yet given way to sloth, the quest for leadership and dominance is also the engine for progress.

A review below of a few leading antitrust cases dealing with market dominance in high–technology industries suggests some of the scenarios in terms of which these issues can usefully be analyzed. In the three sub–sections below, we offer some tests that could be used to sort out the various motives. We are aware, however, that many scholars and policy makers question whether workable antitrust rules can be developed to account for the realities of technological competition.[15]

[A] **Systems Competition.**

The first broad category of pertinent market scenarios can best be described as those entailing systems competition. Here, consumers desire systems that can be built up from components manufactured by the dominant firm, but a few components may also be provided by rivals. That is, consumers cannot assemble a system that consists solely of components manufactured by competitors of the dominant firm. In order for mixed systems to be functionally equivalent to systems consisting solely of the components manufactured by the dominant firm, all the components must be perfectly compatible.[16] In this setting, the dominant firm has a potential strategic advantage over its rivals in that it can set the interface standards between components; it can redesign these standards, thereby reducing the useful life of the previous generations of compatible components manufactured by rivals; and it can refuse to disclose these standards to rivals, thereby forcing them to incur possibly significant costs of reverse engineering at the interface.

All of these strategies have the effect of reducing competition in the provision of compatible components while increasing the appropriability of R&D investments made

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[15]This view is well expounded in many articles written by the now federal judge, Frank Easterbrook. See, e.g., Easterbrook [1984]. For more on our own views, see Baumol and Ordover [1988].
[16]Matutes and Regibeau [1988] study a model in which interface standardization increases the variety of systems that can be assembled but also leads to higher system costs.

by the dominant firm. What is to be done about the use of such strategies? Should a dominant firm be free to set interface standards without pre–disclosing them to rival manufacturers of compatible components? Alternatively, should some limits be imposed on the ability of the dominant firm to change the standards?

No uniform answer has been given to this question either by the courts or by scholars. The US courts in *Berkey*[17] and in various IBM cases[18] were reluctant to condemn interface design decisions made by the dominant manufacturers of the relevant products (cameras and film, and central processing units, respectively). The courts have reasoned that design decisions are best left to the companies themselves and that no easily workable and defensible legal standard can be devised to test whether or not these decisions act primarily to serve the anticompetitive purpose of vanquishing the manufacturers of compatible components. In the absence of such simple legal standards, the need to preserve incentives for investment in R&D should take precedence –– according to the courts –– over the desire to forestall the potentially adverse consequences for static competition that might result from a possible reduction in the number of independent manufacturers of compatible components.

In yet another case, *Northeastern Telephone*,[19] the court instructed the jury that where government regulation intrudes on the free operation of the relevant product market, the dominant firm may be able to use its control over interconnections to stymie competition. Obviously, the less pro–innovative stance here is directly

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[17]Berkey Photo, Inc. v. Eastman Kodak Co., 603 F.2d 263 (2d Cir. 1979) considers the competitive implications of Kodak's introduction of the 110 camera and film. The 110 cameras were incompatible with the old Kodak X film, and the new film had to be developed at temperatures that would melt films compatible with the old cameras.
[18]See, e.g, Telex Corp. v. IBM, 510 F.2d 894 (10th Cir. 1975) and In re IBM Peripheral Devices Antitrust Litigation (Transamerica), 481 F. Supp. 965 (N.D. Cal. 1979), in which the courts considered the competitive implications of IBM's introduction of the System 370 central processing units for rival manufacturers of plug–compatible peripherals.
[19]Northeastern Tel. Co. v. Am. Tel. & Tel. Co., 651 F.2d 76 (2d Cir. 1981)

attributable to the fact that regulation can distort incentives to undertake socially desirable investments in R&D and can increase the likelihood of predatory conduct.[20]

In their action against IBM,[21] European antitrust authorities weighed the balance between ex post competition in plug–compatible equipment and ex ante incentives for R&D investment in a different manner from that of the US courts, which had had the opportunity to scrutinize IBM's technological decisions. The EC authorities insisted that IBM disclose interface changes to rival manufacturers of plug–compatible equipment in advance of the introduction of interface changes, in order to enable these rivals to be ready with new generations of equipment when IBM is ready. The actual settlement, which was regarded as a victory by both sides, gave some advance notice to the rivals without denying IBM a degree of first–mover advantage. Hence, contrary to initial fears (or hopes), the EC settlement did not drastically reduce the appropriability of investments in the creation of new technology by IBM. More important, however, even though the settlement affected IBM's operations in the EC only, it had much broader competitive implications. Information disclosure cannot be localized. Technological information is a public good, and once it is disclosed in one geographic market it is apt to become available in other markets. Furthermore, rivals who gain this competitive intelligence in one market are capable of using it in other markets as well.[22]

In terms of fashioning a public policy response to the issues raised by systems competition, three possibilities are available. First, one can adopt the position that courts are not well suited to analyze the pros and cons of various technological

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[20]See, e.g., Ordover, Sykes, and Willig [1985] for a discussion of the impacts of rate–of–return regulation on incentives for non–price predation.
[21]IBM Corp., (settlement), reported in Antitrust & Trade Reg. Rep. (BNA) No. 1177, p. 272 (Aug. 9, 1984).
[22]See the discussion in Ordover [1984] and the remarks by Baxter [1984].

decisions, including those concerning interface design.[23] Consequently, antitrust laws should not be used to scrutinize those decisions unless it can easily be shown that the chosen design represents a technological setback.[24]

At another extreme, one can adopt the position that dominant firms must provide all vendors with equal access to the components. This position translates into the Comparably Efficient Interconnection (CEI) and Open Network Architecture (ONA) prescriptions for system design. This policy prescription has so far been limited in the US to Bell Operating Companies (formed after the break-up of AT&T), as a precondition of their being allowed to provide enhanced telecommunications services and customer premises equipment without setting up separate subsidiaries for these purposes.[25] In effect, CEI requires competing vendors to be provided with access to the telephone network on the same basis as has the Bell Operating Company. ONA requires that the components of the telephone network be provided on an unbundled basis to competing vendors so that they can configure their own systems for sale to the users of telecommunications services.[26] Implementation of ONA is another matter because it requires careful consideration of the costs and benefits of the different degrees to which services can actually be unbundled. Furthermore, if ONA is to accomplish its desired objectives, networks must be designed in a way that actually permits effective unbundling in the provision of services and access. Yet there is no reason to suppose that such network configuration is the most efficient in the static sense.[27] Furthermore,

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[23]This position is articulated at length in a leading US antitrust treatise. See Areeda and Turner [1975] and Areeda and Hovenkamp [1986].
[24]The plaintiffs in the Berkey case tried to demonstrate that Kodacolor II was in fact inferior to the preexisting film.
[25]This is the gist of the Federal Communications Commission's decision in Computer Inquiry III, 60 RR.2d 603 [1986].
[26]See, e.g., Besen and Saloner [1988] for an excellent discussion of diverse policy issues raised by standardization.
[27]Sidak [1983] provides the standard arguments that technological bundling of components may be efficient. Ordover, Sykes and Willig [1983] question some of the points raised by Sidak.

the presence of CEI and ONA can conceivably reduce the appropriability of investments in network design by the dominant firm, thereby retarding long–run efficiency.

Ordover and Willig have proposed a test for systems design (or redesign) that attempts to balance these two extreme policy approaches.[28] The basic premise of their test is that the dominant firm should have almost complete latitude in selecting product designs for system components, including interfaces between components. If, however, product innovation renders the old and the new components incompatible, causing the exit of a rival component manufacturer, the profitability of the innovation can be evaluated using the "compensatory pricing test."[29] If the innovation fails the test, then there is a plausible presumption that its primary purpose was to damage the rival rather than to advance the state of technology. In theory, at least, the compensatory pricing test is reasonably straightforward: It seeks to determine whether the innovation would be profitable if the innovator were to continue to offer to sell the old components to the rival at prices that fully reflect (a) current production costs and (b) profits lost on whatever sales may be diverted from the innovator to the rival in the event that the rival could sell compatible components while paying compensatory prices for the needed components of the innovator. In practice, however, the application of the test raises difficulties associated with the calculation of current production costs of old (and possibly discontinued) components, and of the appropriate diversion compensation.[30] Nevertheless, the test provides a framework that can be used

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[28]Ordover and Willig [1981]

[29]The structure of the market should be evaluated before the test could be applied, according to the Ordover–Willig approach. The structural test examines not only concentration in the relevant market but also the extent of entry and reentry barriers. Thus, for example, if the rival can re–configure or redesign the old components quickly and at a low fixed cost, there should be little concern for the competitive consequences of redesign decisions on rivals.

[30]It may be worth mentioning that the compensatory pricing test has been used in the low–technology railroad industry for the purposes of determining charges between interlining railroads.

not only to calculate the appropriate charges for access to a dominant firm's components but also can be used to balance the competing requirements of maximum diffusion of information and secure appropriability of the benefits from innovation.

[B] **Product Preannouncements.**

When the pace of technological change is quick, the innovator may want to alert buyers to forthcoming product introductions. Alternatively, the innovator may choose to delay the announcement of an innovation in order to deny information to rivals. We have hinted at the latter when discussing changes in interfaces among system components. To summarize, when the innovator delays disclosing information about the new product, it gains a first–mover advantage over imitators. Such a first–mover advantage may be critical to the financial success of the innovation, especially when imitation is cheap and easy and patent protection is insufficient. Consequently, if the prospective innovator is forced to pre–disclose the design changes well ahead of introduction, the effect may be a repression of socially beneficial product innovations.[31]

A different set of issues arises when a dominant firm preannounces the product substantially ahead of its actual introduction.[32] One possibly anticompetitive consideration underlying such early preannouncement is its effect on the revenues of rival firms.[33] If, as a result of an early preannouncement, prospective buyers decide not to purchase rivals' products, these firms may suffer substantial reductions in their cash flows and their viability may be endangered. The reverse side of this is that as a result of an early announcement the innovator also must forego sales of its old models.

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[31]See our discussion of the IBM settlement with EC. As we mentioned already, the US courts have uniformly rejected the view that the dominant firm has a duty to pre–disclose new product introductions sufficiently ahead of time to enable the manufacturers of compatible components to gear up their productive facilities. See, e.g., Berkey v. Kodak, op.cit.; Memorex Corp. v. IBM, 636 F.2d 1188 (9th Cir. 1980).

[32]See U.S. v. IBM, No. 69–200 (S.D.N.Y., filed Jan. 12, 1969) (Complaint at 20–21).

[33]This paragraph is based on the argument presented in Ordover and Willig [1981], Appendix, pp. 52–53.

Still, if the early announcement is likely to induce exit of the rival (even if only temporarily), the remaining incumbent may pick up some of the sales that would have gone to the rival from those buyers who are too impatient to wait for the new product. These diverted sales reduce the intertemporal costs of an early announcement and may provide the needed incentive for a dominant firm to announce new products earlier than it otherwise would.

There are very few formal models of strategic preannouncement. Farrell and Saloner [1986] examine this strategy in a simple case where the innovator has no market for the "old," competitively supplied, product. Buyers' incentives to purchase a product depend on the size of the installed base -- there being scale economies on the demand side. If a monopolistic innovator preannounces, it reduces the installed base that the competitive technology would otherwise have when the new product became available. This may make introduction possible that otherwise might not have been. This can all be for the best if the new product is a substantial improvement over the old. If it is only a marginal improvement, its introduction may reduce welfare because it leaves stranded those locked into the old technology. Which way this balance comes out depends on the variant of the model used.

Unfortunately, this analysis does not deal with the relation of the preannouncement to the installed base of the dominant firm. This omission seems serious because it is unlikely that a firm without a substantial market share at the time of the preannouncement would be subjected to antitrust scrutiny of its product announcement strategies. It must be concluded, therefore, that we have no workable models of the effects of preannouncement in settings that may attract antitrust scrutiny. In any event, even if we did, there would be reasons to treat product preannouncement as being presumptively legal. A diversity of considerations may underlie the decisions about the timing of disclosures, making it difficult to fashion an easily implementable test for anticompetitive product preannoucements. In addition, remedies other than those offered by antitrust may be available to attack those deceptive and overly sanguine announcements of new products that impose costs on consumers without bestowing the decision–making benefits that flow from improved information.

[C] Blocking Patents and Preemptive Innovation.

In a technologically progressive industry, the dominant firm cannot hope to maintain its market position unless it succeeds either in producing new knowledge in the form of new products or production processes, or in preventing actual and potential rivals from doing so. One possibly effective method of fencing out potential competitors entails an over–accumulation of patents, thereby forming a patent "thicket" that can help to prevent others from successfully designing around them.[34] It is not exactly obvious, however, how can one determine from the data whether or not the innovator is patenting anticompetitively in order to block "the development and marketing of competitive products rather than primarily to protect its own products from being imitated or blocked by others."[35] It is possible also that the entire distinction has an air of metaphysics, at least as a guide to the formulation of public policy in this area.[36]

This issue arose in *SCM Corp. v. Xerox Corp.*[37] SCM, a reasonably successful coated–paper copier manufacturer, alleged that Xerox monopolized the plain–paper copier (PPC) business by accumulating patents flowing either from internal investments in R&D related to xerography (reprography) and copying or from acquisition of such

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[34]See Kaplow [1984] for an extensive discussion of patent monopolies from a legal/economic perspective.
[35]SCM Corp. v. Xerox Corp., 463 F. Supp 983, 1207 (Newman, J.).
[36]See Gilbert [1981] for a discussion of the issues and policy prescriptions.
[37]463 F. Supp. 983 (D. Conn. 1978), 645 F.2d 1195 (2d Cir. 1981).

patents from third parties.[38] By the mid–1970s, Xerox held over 1000 patents, of which 60 to 65 percent were not used.[39] In addition, Xerox refused to license patents related to PPC technology to others, including SCM.

On appeal, the court did not address the distinction between lawful and unlawful blocking, because the jury earlier found that Xerox's patenting was not designed with the intent to prevent others from developing competing patents and products.[40]

Economists' theoretical models from the past few years are replete with examples of the use of patents for what could possibly be anticompetitive blocking.[41] Seen in the simplest terms, the incentive for preemptive patenting arises when the monopoly profit to the innovating incumbent (π^m) is (weakly) higher than the sum of the profits accruing to the non–innovating incumbent (π^i) and the innovating entrant (π^e). This point is clearly demonstrated in the Gilbert and Newbery (1982) (G&N) "auction model" of a patent race. There the analytics are particularly simple: Two firms bid for the right to engage in an R&D project. The project comes to fruition at

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[38]Scherer [1981], p. 292, points out that his review of a sample of reprography patents drawn from a ten–month period in 1974 failed to uncover a single patent granted to SCM. He suggests that SCM's antitrust action may be a direct result of its entrepreneurial failure.

[39]In his comments, Shapiro questions the social "desirability" of sleeping patents. He wisely, we think, does not suggest that such patents should come under compulsory license provisions. He points out that sleeping patents may, in fact, have some social value if they provide incentives for developments of other patents.

[40]The court also held that lawfully acquired patents are not subject to compulsory license. In doing so, the court refused to "proscribe the rational *natural evolution* of a patent monopoly into an economic monopoly." Regarding the lawfulness of a patent acquisition, the court identified the following key issues: (1) the market power occupied by the purchaser of the patent at the time of the acquisition, (2) whether the seller of the patent is a competitor, and (3) the extent to which the patent will create market power, as measured at the time of acquisiton.

[41]See Gilbert and Newbery [1982] for an early example. A rather technical review of the pertinent literature is in Reinganum [1988] and in Gilbert [1988].

time T(x), where x is the amount bid. Only the winner actually incurs x; the loser expends nothing.[42] In this scenario, the incumbent selects the largest x* such that $\pi^e \cdot \exp\{-rT(x)\} - x = 0$.

The potential social cost of a preemptive innovation, in the G&N model, is that it perpetuates monopoly in the product market even though a more competitive market structure is possible. This problem cannot be cured by compulsory licensing, without also setting a license fee. This is due to the fact that the winning incumbent can always set a fee that imposes a perfect vertical price squeeze on the entrant. Licensing can, however, ameliorate another inefficiency that may arise in the G&N model, which is that the less efficient incumbent can still win the patent. As Salant [1984] pointed out, in this case the incumbent will license the patent to the entrant for at least a compensatory price, and probably for more. Here, the higher price will reflect the incumbent's transfer to itself of a portion of the efficiency gains from having the patent developed by the entrant.

The model of Katz and Shapiro [1987] (K&S) goes a long way toward clarifying the distinction between the two blocking incentives mentioned at the beginning of this section. In their model, there are two firms, i=1,2, each receiving a flow of profits of π_i^0 before adopting the new technology. If firm i adopts first, its profits are π_i^i;[43] if the rival adopts first, firm i's profits are π^{ij}. From the standpoint of firm i, the "innocent" incentive to adopt or invest in a new technology is associated with the difference $(\pi_i^i - \pi_i^0)$. K&S term this a "stand-alone incentive," for obvious reasons. The difference $(\pi_i^i - \pi_j^i)$ provides, in K&S's terminology, the preemptive

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[42]If the sunk cost of the race were ϵ, then a possible equilibrium involves no entry threat because the entrant is sure of losing the up-front investment of ϵ inasmuch as the entrant is always loses the race, if the G&N profit conditions are satisfied.
[43]Unlike G&N, K&S allow for post-auction licensing of the patent as well as for imitation by the losing firm.

incentive to invest. This difference reflects the fact that the fear of losing spurs the desire for winning. A similar distinction between "defensive" and "aggressive" innovation was proposed by Ordover and Willig [1985] (O&W) in their analysis of the economic effects of research joint ventures, albeit in a much simpler setting.

The set of incentives for innovations proposed by K&S and O&W is related to the benchmark offered by Ordover and Willig [1981] in their test of predatory innovations. Ordover and Willig [1981] argue that a nonpredatory innovation is the one that would be undertaken by a dominant firm even if the rival were to remain viable after adoption of the innovation. Viability for a rival firm can be interpreted as the ability to maintain access to the old technology (or products) and, perhaps, to participate in future R&D auctions. The net profitability of an innovation to a dominant firm with a viable rival is measured by K&S as the quantity $\pi_i^i - \pi_i^0$.

Should public policy restrict dominant firms from taking into account the quantity $(\pi_i^i - \pi_j^i)$ when making R&D-related decisions? Unfortunately, the answer is unclear. Two considerations work in opposite directions. On the negative side, such a policy is most likely to retard the adoption of the new technology, as in the K&S model, or to reduce the amount that a firm is willing to pay at an R&D auction, thereby postponing the time at which the innovation will become embodied in the new process or product. To the extent that private incentives to invest in R&D and to adopt new technologies fall short of social incentives, any policy that further exacerbates this disparity is apt to reduce social welfare.

On the plus side is the possibility that the policy may improve the ex post market structure. Thus, under the K&S structure, consumers might benefit greatly from stand-alone innovation as opposed to preemptive innovation, even though innovation overall would be slower. The welfare gains would come from enhanced competition and lower ex post prices.

But how important is this consideration? The answer is that it is probably not that important. As Reinganum has effectively argued in a series of papers,[44] when R&D competition is modeled as a stochastic race with an uncertain outcome, the incentive to preempt is not as strong as it is in auction or game–of–timing models of R&D competition. The point is that in a stochastic race the ability to preempt is probabilistic; hence it receives a smaller weight than it does in a deterministic model.

This precis suggests that the balance between the two sets of incentives depends on how one depicts technological competition. Plainly, dominant incumbent firms have incentives to induce exit and discourage entry of technologically capable rivals. R&D competition affords plenty of possibilities in this regard. Nevertheless, great caution should be exercised in scrutinizing technology–based strategies. Indeed, with the sole exception of Ordover and Willig [1981], economists have been quite loath to derive explicit antitrust rules that would assist policy makers, judges, and juries in their tasks of formulating and applying antitrust policies to technological competition.[45]

3. Licensing of Innovations

In the previous section, we analyzed unilateral business strategies of dominant firms. We now turn to cooperative conduct among firms in the technological arena. We begin with licensing, a convenient place to start because licensing entails possibly the minimum degree of cooperation among stand–alone rivals. Licensing of innovations

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[44]See the Reinganum [1988] survey for a discussion of models of R&D races involving dominant firms. See also Vickers [1984], who constructs a model in which in some equilibria dominance is only transitory while in others the same firm wins every technological race.

[45]It must be noted here that the O&W [1981] rules have been criticized as being difficult to apply and possibly welfare–lowering rather than welfare–enhancing. Obviously, at least one of the co–authors of this article differs with some of those assesments. Possibly, Salop's, and his coauthors', "raising rivals' costs" viewpoint could also be applied to various dimensions of technological competition. See Salop and Scheffman [1987] and Krattenmaker and Salop [1987].

creates the potential for social gains from improved ex post diffusion of existing innovations, but it also carries with it the risk that the process will be abused, and turned into a means for effectuating collusion at the upstream (R&D) and downstream (product) levels.

As usual, our view is that the licensing process ought to be relatively free of antitrust scrutiny. The bases for this view are as follows: (1) To the extent that private firms already have inadequate incentives to enagage in ex post dissemination, policies that interfere with dissemination may only exacerbate the problem; (2) To the extent that contracting for the sale and purchase of information through licensing is fraught with significant transactional difficulties, a good deal of latitude should be granted to licensors, who must protect themselves against free riding and uncompensated disclosure; (3) To the extent that price and non–price vertical restraints improve static efficiency, when those restraints are applied to the sale of information they are even more likely to be conducive to social efficiency; (4) To the extent that revenues from licensing add to the innovator's profit, they enhance entrepreneurial incentives to invest in the production of information and knowledge; (5) To the extent that licensing improves dissemination and adds to the effective stock of knowledge, it can reduce wasteful duplication of R&D efforts and can redirect R&D funds toward less imitative pursuits.

Our discussion in this section begins with a review of the private and social incentives for dissemination. We pay some attention to those forces that potentially create a wedge between these two sets of incentives. We then address restrictions on licensing schemes and try to get a handle on what may constitute the potential for the abuse of a patent through licensing. Finally, we say a few words about compulsory licensing and conclude that its ex post benefits only rarely, if ever, exceed its ex ante costs.

[A] **Licensing Incentives.**

From the social standpoint, licensing of an existing innovation should be guided by the objective of maximizing social welfare. To the extent that information could be disseminated at zero marginal cost to the firm or person that produced this information, welfare maximization would call for licenses with zero usage fees.

Ex post welfare maximization does not provide an appropriate foundation on which to construct socially optimal licensing policies. This is due to the fact that policies constructed on such a basis would render the whole process of the production and dissemination of knowledge financially nonviable. There are significant fixed costs to the production of new knowledge, and these costs have to be somehow recouped. If licensees do not pay directly for the information embodied in the license, the requisite funds will have to come from elsewhere. Most likely, the funds will be generated from general tax revenues. Unfortunately, these subsidies to the production of new knowledge are not obtained by means of non–distortionary, lump–sum taxes. Rather, they are generated from taxes that have significant average and marginal deadweight costs. In short, society cannot escape distortionary taxation. The question is where those distortions should first appear.[46]

Our own predilection is to impose costs on those who cause them. Here it means that we would generally favor licensing new knowledge to those who use it directly, rather than recoup the up–front costs of R&D indirectly from the ultimate beneficiaries (i.e., consumers) by means of taxes. Only R&D expenditures that have very high spillovers are appropriate candidates for subsidies financed from general taxes (see Spence [1984]).

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[46]In Baumol and Ordover [1977] we derive simple second–best prices for exclusionary public goods.

Private licensing decisions are driven by the profit motive. In making a decision whether and how to license, an owner of a piece of valuable information must weigh incremental revenues from patenting and licensing against increased downstream competition and the increased likelihood of future competition from licensees who might benefit in their own R&D from having working access to the patent. Thus, a private knowledge–producing organization looks to a license as a possible important source of funds but also as a possible source of current and future competitive pressures. (Later, we will say something about licensing and collusion.)

When a firm that is not vertically integrated licenses a process patent to a homogeneous downstream industry, it will set the user fee at the level equal to the difference between marginal cost with the new technology and marginal cost without it. This strategy enables the innovator to capture the full social gains from the innovation.

When knowledge is licensed to a downstream monopolist, the profit–maximizing arrangement calls, theoretically at least, for a fixed license fee and a zero usage fee. Any other arrangement creates the distortion associated with double–marginalization, which occurs whenever an innovator marks up the marginal cost of dissemination and then a monopolist marks up the marginal cost of production.[47] Socially optimal licensing has the same structure. Here, however, underutilization of information is not attributable to the monopolist's having too high a marginal cost, but, rather, to the fact that the licensee charges too high a price for the product embodying the new technology. To the extent that there are deadweight costs of monopoly, ex post returns to an innovator are lower when it licenses to a monopolist

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[47]Note that imposing a positive fixed fee on competitive firms creates its own problem, which is that it converts a constant–returns technology into an increasing–returns technology. This means that the competitive industry would become converted into a natural monopoly. Whether this is a problem depends on how serious one is about perfect competition and constant returns to scale as realistic descriptions of any known market.

than when it licenses to a competitive industry. However, if there is free entry into the upstream (innovator) stage, in either case expected profits from innovation are zero. This means that there will be more firms participating in the R&D game when the downstream industry is less concentrated.[48]

The model pursued thus far, while instructive, is not very realistic for a variety of reasons. First, it does not consider the consequences of licensor interactions on the optimal license fee. Second, it does not consider the incentives for licensing by an innovator who is integrated into the relevant downstream market. Third, it does not consider licensing behavior when there is more than one actual or potential licensor. We do not have space to address all these complications in full, but we will note the key issues here and in subsequent sections.[49]

(i) **Demand Interdependencies.** When there are demand, and other, interdependencies among licensees, the licensor must take these into account when setting the profit–maximizing license. Ordover and Panzar [1982] worked the problem out in a case where the downstream industry is composed of heterogeneous perfectly competitive firms and the licensor is a monopolist. The profit–maximizing licensing scheme is a highly complex nonlinear usage–based schedule. The schedule encompasses the fact that a lower usage fee to some firms implies lower efficiency rents to other firms, which, in turn, reduces the amounts that can be captured from those firms by means of nondistorting license fees. In particular, the marginal usage fee always exceeds the marginal cost of dissemination.

When the downstream market is oligopolistic, additional complications arise from strategic interactions among licensees. These have been studied by Kamien and

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[48]Reinganum [1988] discusses the links among rewards, the number of firms, and the timing of innovations as a function of ex post rewards to the vistor in the R&D game.
[49]A fourth consideration is that the model does not consider the transactions costs associated with the sale and purchase of knowledge. We deal with this later in the section on restricting licensing schemes.

Tauman [1984, 1985], Kamien, Tauman and Zang [1985] and Katz and Shapiro [1986]. As Shapiro notes in his 1985 survey, "it is generally not optimal to sell the licenses using the conventional price system. That is, it is not optimal (for the patentee) simply to set a price per license and let the firms each decide whether or not to purchase a license at a set price."[50] The optimal mechanism in the Katz and Shapiro [1986] model calls for auctioning of $k < n$ licenses, where n is the number of downstream oligopolists. Surprisingly, such an auction can leave winners (and losers) worse off than they would have been had there been no innovation. This is due to the fact that each winner scrambles to get insurance against the possibility that it will be left out in the cold while its rivals will get the coveted license.

Obviously, this stems from buyers' having very little threat power over the licensor and there being no present (or contemplated) competition in the provision of new technology to the downstream industry. Nevertheless, this result shows that restricted auctions of licenses can have detrimental consequences for downstream competition. In particular, the licensor can use the auction to "replicate" the fully collusive outcome, using licensing as a facilitating device. It then extracts the full monopoly profits accruing to the downstream oligopolists. The model suggests that antitrust may perhaps take a dim view of (restricted) auctions of licenses and insist that the owner of the property right in the patent rely on a simple price mechanism to exploit that property right.

It is unlikely that this prescription will find a receptive hearing among many policy makers and judges, especially those of the Chicago bent. This is due to the fact that such a restriction would impose on the owner of an intellectual property constraints that would not be imposed on the owner on any other type of property.

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[50]Shapiro [1985], p. 28.

However, in insisting that there be no such differential constraints, one misses the signal point that intellectual property has public–good characteristics that could inject special considerations into the conditions of its sale.

(ii) **Vertically Integrated Innovators.** In choosing the licensing mechanism and a fee structure, a vertically integrated innovator must factor in the effects of licensing on the profits of its "downstream division." The downstream effect can be controlled if the licensor can impose per–unit royalties or usage fees. The control stems from the fact that royalties affect the licensee's marginal cost, hence its competitive prowess (as reflected in the location of its best reply function). When only a fixed fee can be used, the patent–holder may choose not to license. Katz and Shapiro [1985] show that a drastic innovation will not be licensed in the absence of royalty fees. This result follows from the fact that fixed–fee licensing increases downstream competition, which dissipates profits. Unless the innovator can recapture a portion of these dissipated profits, it will choose not to license. Consequently, prohibition on per–unit royalties represses the diffusion of new technology. Besides, by reducing the return to an innovation, it also weakens the initial incentives to invest in patentable knowledge. On the other hand, in a simple model, a prohibition on royalty licenses has no effect on the price of the final product.

Given that a vertically integrated innovator has less of an incentive to license than does an independent research lab, one may be tempted to conclude that some gains can be achieved by universal vertical disintegration. Nothing could be further from the truth. In fact, such a policy is a prescription for long–term technological disaster, for a variety of reasons. Paramount among these are (a) significant synergies between invention and innovation, and between research and development activities, and (b) market failures associated with arm's–length sales of information (see below).

When a licensable patent is owned in a joint venture by a number of vertically integrated firms, yet another set of considerations intrudes. Now the co–

venturers must consider not only how to license the patent among themselves but also how many licenses to issue the outsiders. Katz and Shapiro [1986] show that larger joint ventures need not issue more licenses in total. Their results thus belie the notion that joint ventures are invariably conducive to greater dissemination of new knowledge. The problem here is that the model is somewhat stylized, and we have little intuition as to the generality of the results.

(iii) **Multiplicity of licensors.** So far, we have considered the incentives to license new technology subject only to the constraint that the licensees have continued access to the old technology. Licensing decisions often take into account additional considerations. These include, among others, (a) the need to obtain complementary technology from other, potentially rival, firms, and (b) the use of licensing to discourage production of competing innovations. Both considerations raise some troubling antitrust policy issues. Unfortunately, they are not easily dealt with.[51]

Policy makers must be able to perceive and use the essential distinction between these two considerations. Genuine needs often exist for cross–licensing and waivers of exclusive patent rights; such arrangements yield real economic benefits. Sham licensing arrangements, in contrast, facilitate collusion, exclusion, and repression of investment in R&D. Andewelt [1984] suggests that patent pools can be analyzed using the same principles that are appropriate for merger analysis. He correctly points out that the analysis must be carried out on two levels: first, in the upstream market, where the members of the pool compete with each other in the licensing of innovations; and second, in the downstream market, where the pool members compete with each other in the provision of products that embody the cross–licensed information.

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[51]Shapiro notes also that when licensors hold competing technologies they may underprice the technology in the marketplace. This would not be a source of concern if it were not for the fact that some of the licensees are foreign firms that thereby capture a portion of monopoly rents that would otherwise accrue to home innovators.

If the Merger Guidelines methodology is to be followed, the relevant upstream markets and market shares must be specified. Abstracting from market definitional issues, it seems clear that once the relevant market has been defined, the measurement of market shares and concentration presents a severe analytical challenge. Plainly, if the members of a cross–licensing pool do not pay royalties to each other but merely share information on an equal basis, revenues cannot be used to assess shares and concentration. Similarly, the notion of capacity does not make sense inasmuch as the information embodied in the licenses is an excludable public good. Finally, the total R&D assets controlled by the cross–licensors may be a misleading measure of the importance of the pool if some of those R&D assets could be deployed for other projects not related to the pooled patents.

One, albeit not very satisfactory, way out of this web of difficulties would be to inquire whether a merger (or a joint venture) of the pool's members would be allowed to go ahead. If the answer is in the affirmative, then a lesser degree of coordination should also be permissible. However, probably more often than not, a merger would be disallowed. In this instance, we must fall back on the full rule–of–reason investigation of the purposes of the pool and of the cross–licensing practices employed by the members. As Andewelt ([1984], p. 626) notes, open pools can create greater anticompetitive problems when their main concern is with collusion and incremental market power. On the other hand, "underinclusive" pools can be challenged by outsiders on the basis of exclusionary effects. We would limit challenges on the latter grounds for fear of opening the floodgates of "essential knowledge" litigation.

The analytic challenge facing public policy makers is severe also when it comes to identifying licenses granted with the purpose of discouraging a rival firm from innovating on its own. That such licensing is possible has been shown by Gallini [1984] and Gallini and Winter [1985]. There is no indication whether it is likely to be either frequent or successful in the long run. Thus, it seems to us that there is very little analytic basis on which to employ antitrust machinery to examine licensing for strategic motives of deterring rivals' R&D.

[B] **Restrictions on Licensing Schemes.**

In practice, license agreements are much more complicated than the simple royalty or fixed–fee arrangements considered above. The terms of the license may include minimum prices the licensee may charge for products manufactured using the licensed process, territorial restrictions on where the license can be exploited, tie–ins, "technology flowback" clauses, restraints on the licensee's utilization or development of technology that is prospectively competitive with the licensed technology, etc.[52] Matching this unbounded ingenuity of licensors and their lawyers in fashioning the terms of patent licensing agreements is an unbounded literature on the restrictions that antitrust laws place, or should place, on licensing provisions.[53]

The legal literature is framed on the pro–patent side by the views propounded by Bowman [1974], who developed the "competitive superiority" test.[54] Under the test, a patentee can charge whatever the traffic will bear, up to the patented product's "competitive superiority" over substitutes. Among the difficulties with this view, such as those that attend the practical measurement of competitive superiority, is that Bowman tends to infer competitive superiority from the fact that the licensees are willing to accept the terms of the license. It is precisely in the problematic situations that this inference is incorrect. In such instances, the terms of the license are used as a cartelizing or facilitating device, so that the acceptance of the terms of the license

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[52]See Taylor and Silberston [1973] and Caves, Crookell and Killing [1983] for more detail on licensing practices.
[53]See Turner [1984] for an excellent brief discussion of various licensing schemes and their antitrust treatment.
[54]This and the following paragraphs are closely based on Ordover [1984].

reflects not only competitive superiority but also additional profits from incremental collusion.[55]

Baxter's [1966] test is geared to minimizing the welfare loss attendant to the exploitation of the patent.[56] The potential shortcoming of this test is that it may under–reward investments in the creation of new information, thereby exacerbating whatever market failure may already exist.

We can apply these two tests to so–called "price–restrictive licenses," meaning licenses that have in them provisions as to the minimum (or maximum) prices that licensees can charge for the products covered by the patent. Bowman ([1974], pp. 129–139) treats such restrictions as analogous to vertical price maintenance (RPM) and thus concludes that on balance they enhance efficiency. Baxter ([1966], pp. 336–337) concludes otherwise, finding that such price–restrictive licenses facilitate collusion and diminish incentives to innovate around the patent because the full value of the patent is not transferred to the licensor.

Bowman's resolution of the issue fails to reflect the fact that the licensor and licensees could be horizontal competitors in the downstream market. Consequently, the standard economic analysis of RPMs cannot be applied without at least some modification. Furthermore, the standard justification for RPMs is free riding, and Bowman fails to explain why this justification should apply in this instance. Baxter's resolution is not sensitive to the fact that it may be impossible for the licensor to calculate the level of the royalty (usage fee) that would precisely and over time closely

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[55]Here the queries are (a) why the industry participants had to wait for the new patent to accomplish the desired cartelization and (b) why the prior patents hadn't accomplished the trick.

[56]See Kaplow [1984] for this characterization of the Baxter test and for an extensive discussion of Bowman's test. Kaplow offers a (convex) combination of Bowman and Baxter in his "ratio test," which focuses on the consequences of a particular licensing scheme on the ratio of patentee revenues to the deadweight loss of monopoly caused by the licensing practice. See Ordover [1984] for a brief critique.

track whatever cost differentials may exist between the licensor and the licensees. Because of asymmetric information about the costs and because the the licensees may be unwilling to reveal that information, a price–restrictive license may be the only way for the licensor to ensure that the licensees do not drive him out of the market and lessen his ability to participate in the future technological races. In addition, if the usage fee is calibrated correctly, the licensor can implement a collusive price that the licensee cannot undercut without going below marginal cost. With a price–restrictive license there may be some room for profitable defection from the collusive agreement, however.

As the preceding paragraph suggests, our own view is that antitrust should impose only minimal restrictions on licensing schemes.

(1) If the licensor is not vertically integrated into the downstream market, either directly or indirectly through the patents (as may be true in the case of a research joint venture), it should be allowed to exploit its patent almost without any restriction. The major caveat here is that a stand–alone licensor should not be permitted to impose license terms that substantially reduce the likelihood of present and future independent competition from the licensees in the upstream R&D and licensing market. It should be noted in this regard that the licensees themselves may be only too willing to accept such conditions, if by doing so they reduce costly technological competition among themselves. There is some social benefit even in that, if there is too much duplicative R&D already. Furthermore, some such restrictions may be necessary in order to reduce returns from imitation and to prevent unauthorized leakage of licensed technology.

(2) If the licensor is vertically integrated into the downstream market, its licensing strategies warrant closer antitrust scrutiny. This follows from the fact that a vertically integrated licensor may employ license terms to facilitate downstream

collusion. One perhaps fanciful scenario has a licensor employing a two–part tariff licensing scheme with a positive usage (royalty) fee to raise costs and a negative fixed fee to transfer some of the collusive profits to the licensee. This suggests that licenses with a negative fixed fee could in some market scenarios implement inefficient outcomes. We have also seen that quantity–restricted auctions of licenses could be a signal for anticompetitive conduct. Possibly, antitrust principles could be applied to those.

(3) Because of high transaction costs and the potential for market failure in the licensing process, licensors and licensees may have to resort to complex licensing arrangements in order to realize intrinsic gains from trade. These transactional difficulties arise because of (i) the presence of asymmetric information about the value of the patent, (ii) the fact that the value of the license diminishes if part of the relevant information is transferred by the licensor to the licensee in order to convince the latter about the value of the patent –– such unrecompensed transfers of the valuable information without fee is the essence of imperfect exclusion and inappropriability of information, (iii) the fact that once the information covered by the license is transmitted, the licensee's ability to imitate is increased and the value of the knowledge asset to the seller is reduced, and (iv) the possible inability of the licensor to monitor ex post the intensity of exploitation of the patent (Shapiro [1985], pp. 26–7). Consequently, licensors should be allowed to utilize schemes that reflect these contracting problems. This means in practice that any provisions that could be related to improved monitoring of exploitation of the patent and to enhanced appropriability should be accorded the presumption of legality.

(4) In view of the substantial social benefits of ex post diffusion of information and the possibly inadequate private incentives for investment in knowledge production, weaker antitrust standards should be applied to licensing agreements than

the usual vertical restraints.[57] Obviously, per se legality of all licensing agreements is not warranted, given current learning about vertical restraints and given that parties to licensing agreements are frequently horizontal competitors. On the other hand, we see little benefit in treating certain licensing provisions as being per se illegal. We have already argued that even price–restrictive licenses may on balance be procompetitive. The same could be said for exclusive grant–backs of improvement patents. On balance we think that a "relaxed" rule–of–reason approach offers the best protection against abuses of a lawful patent monopoly while ensuring that antitrust prohibitions do not undermine private incentives to produce and disseminate knowledge.

(5) Under the rule–of–reason approach, licensing agreements must be analyzed for their effects on actual and potential competition in the upstream and downstream markets. As a guideline, licensing agreements that do not significantly reduce the likelihood of future competition in the upstream market beyond the level implied by the patenting itself should be approved without much in terms of additional scrutiny.

[C] **Compulsory Licensing.**

Compulsory licensing amounts to forced diffusion of existing knowledge. Obviously, it is unprofitable to the innovating firm(s); whether it is socially undesirable is quite another matter. Because compulsory licensing reduces the profits of the innovating firm, it may plausibly reduce the incentive to invest in knowledge creation. In addition, rivals may cut back on their expenditure on innovation in anticipation of being able to license under the attractive terms of a compulsory license.[58] In the end, the long–term effects of such compulsory licensing can be determined only empirically.

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[57]It is worthwhile remarking, perhaps, that many of the standard vertical restraints are also motivated by informational market failures.
[58]Note that if the patent owner could devise a truly fully compensatory licensing scheme, its incentives not to license would be greatly diminshed, if not completely obviated. Ordover and Willig [1981] note that a socially optimal compensatory price should be net of the profits from a successful predatory or exclusionary strategy.

Scherer provides empirical evidence that the future patenting activity of firms subjected to compulsory licensing declines significantly relative to the control group (Scherer [1984], pp. 207–8). As Scherer notes, focusing on the decline in patenting activity by firms under the decrees may overestimate the social harm of such decrees. Indeed, regression analysis indicates that overall R&D expenditures of the investigated firms were not statistically different form those of other firms in the sample, which suggests that firms subject to compulsory licensing found alternatives to patenting in order to protect their investment in knowledge creation (Scherer [1984], Table 10.2). If innovators substitute secrecy for patents, society loses the disclosure benefits associated with patenting. Finally, Scherer's regressions indicate that compulsory licensing decrees had no statistically significant deconcentrating consequences in the relevant broadly defined product markets.

Cross–sectional analyses, with or without industry dummies, may not be the way to go in studying the effects of licensing decrees. Detailed industry studies that attempt to capture diverse strategic interactions among firms may offer more insight. Bresnahan [1985] provides a demonstration of such a method in his analysis of competition in the PPC market just before and after the 1975 consent decree between Xerox and the Federal Trade Commission (FTC).[59] The settlement obliged Xerox to license its patents to all entrants for nominal fees.[60] Bresnahan argues that Xerox found itself at a strategic disadvantage vis a vis entering rivals, primarily because it owned an overwhelming share of the installed base of PPCs, which it leased at rates significantly above "cost." Since static (price) and dynamic (innovation) competition

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[59]86 FTC Reports 364 [1975]

[60]As Bresnahan observes, existing rivals, including SCM, feared the competitive consequences of such free–for–all technological diffusion. Their prefered solution to Xerox's patent monopoly entailed cross–licensing of patents between Xerox and the existing firms.

directly eroded rents that were previously accruing to its installed base, Xerox was strategically torn. It could choose to hold on to the rents as long as possible by adopting a "fat cat" strategy, or it could simply "bite the bullet" and go after the new rivals with a vengeance. Bresnahan's rendition of the history suggests that Xerox was reducing prices at a slightly slower rate than its rivals. Whether or not it was holding back (in the Arrowian fashion) in the innovation area is much less clear. What is clear is that following the transition period Xerox did not regain its pre–entry monopoly. It did rebound, however, from the adversities that had immediately followed the decree (Bresnahan [1985], p. 17).

Was the FTC consent decree[61] with Xerox in the social interest? It is misleading to employ ex post criteria to assess whether the FTC intervention accomplished its desired objectives. Obviously, Xerox did not anticipate, at least for some time, that its patents would be subject to a compulsory license. Consequently, its R&D decisions were based on the expectation that it would be able to garner all of the gains from its investments in the development and improvement of reprography. We cannot tell what its technological decisions would have been had it correctly foreseen the ultimate fate of its patents. Thus, the ex post assessment of the consequences of the consent decree in *SCM Corp. v. Xerox Corp.* does not convince us as to desirability of compulsory licensing.

4. Joint Ventures and the Production and Dissemination of Knowledge

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[61]Those who measure welfare with nationalistic standards may remark that the FTC facilitated the entry of Japanese manufacturers into the PPC market. As a result, a share of the initial profits that were accruing to the home monopolist (Xerox) were diverted to foreign (Japanese) manufacturers. The neo–protectionist climate that has infected policy making in high technology area would probably discourage a transfer of valuable patents and information to foreign firms. See, e.g., our earlier discussion of IBM's agreement with the EC.

In the previous section we analyzed how independent business entities can carry out profitable dissemination of already produced knowledge through technology licensing agreements. We argued that, for a broad range of possible market scenarios and licensing practices, licensing not only benefits private interests but also serves the public interest. We now turn to cooperative arrangements among independent firms when these arrangements entail not only the dissemination of knowledge but also its coordinated production. In this section, we focus on coordination by means of research joint ventures (RJVs). In the next, we look at mergers in the high–technology industries.

It would take us too far afield to survey the existing literature on joint venture activity in high–technology industries.[62] The literature does suggest that public policy makers easily -- perhaps too easily -- perceive RJVs in two ways. First, RJVs are seen as an effective solution to competitive threats to domestic high–technology industries. This is especially true in the EC member countries and in the US, where home firms are viewed as being at a disadvantage vis a vis the cooperatively minded Japanese firms. Second, RJVs are considered to be a way to gain international market presence -- perhaps even dominance -- in the cutting–edge industries of tomorrow.

With these perceptions in mind, member countries of the EC have underwritten large–scale international research programs such as ESPRIT (European Strategic Programme for R&D in Information Technologies), RACE (Research in Advanced Telecommunication Technology for Europe Programme), BRITE (Basic Research in Industrial Technology for Europe Programme), EUREKA (European

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[62]Vonortas [1988] provides a survey of the literature and a very extensive list of pertinent publications. The interested reader should also consult various reports prepared by the Center for Science and Technology Policy at New York University.

Research Coordination Agency). The Airbus consortium provides yet another example of intra–EC cooperation, heavily financed by the taxpayers of the member states.

In the US, much of the RJV focus is in computing and information– related industries, with semiconductors leading the way.[63] Policy makers' and industries' concerns that US antitrust restrictions could hamper formation of lawful ventures led to the passage of the National Cooperative Research Act of 1984, which brought all RJVs under rule–of–reason scrutiny and limited damages to all appropriately registered joint ventures.[64]

Japan has always been considered (not entirely correctly, we might add) as an example of an economy in which government/industry cooperation under the wise leadership of MITI extends to a diverse set of R&D programs. The VLSI (Very Large Scale Integration) Circuit Research Association is an example of a broadly based, arguably successful, joint research program.

Given the great stock that public policy makers place in RJVs, it is worth reviewing some theoretical models of coordinated investment in R&D and the production of knowledge.[65] This we do in [A] below. The surveyed models suggest that even though RJVs are inspired by a profit motive they generally improve social welfare in a

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[63]Semiconductor Research Corp. (SRC), Microelectronics and Computer Technology Corp. (MCC), Semiconductor Manufacturing and Technology Institute (Sematech), and Very High Speed Integration Circuits project (VHSIC), are the pertinent examples.

[64]5 U.S.C. 4301–4305.

[65]How well RJVs work out in practice is yet another matter. Microelectronics and Computer Technology Corp. (MCC) initially suffered staffing problems because the partners were reluctant to assign their best personnel (human capital) to the venture. At the same time, the partners complained that the research performed by the RJV would be difficult to repatriate if the research staff were composed of outsiders whose allegiance was to the venture rather than to the participating firms. On another dimension, the early software writing consortia experienced problems because participants maintained their own software writing efforts and because some participants refused to market competitive software developed by the joint venture. Harrigan [1986] provides a business strategist's discussion of the challenges associated with successful cooperation in joint ventures. See Vonortas [1988] for a survey of some of the conflicts that may arise in RJVs.

wide variety of scenarios. In section [B], we consider antitrust guidelines for RJVs. We conclude that RJVs should be scrutinized using rule–of–reason principles. We find that as long as the co–venturers involved face a reasonable threat from outside firms in their R&D activities and in their ability to elevate prices after the innovation, the RJV should be allowed to go ahead. We also are of the view that joint ventures should be allowed to impose some restraints on the R&D and the marketing strategies of venture participants. Those restraints that may appear troublesome, such as restraints on independent research, for example, should be scrutinized with an eye toward their role in facilitating cooperation and generating adequate (expected) returns to the R&D investments undertaken by the venture.

[A] **Incentives for RJV Formation.**

It is easy to visualize an RJV as a plausible solution to the market failure problems that plague the production and dissemination of knowledge. RJVs (i) spread the risk of investments in production of knowledge, (ii) reduce unnecessary duplication in R&D expenditures without necessarily diminishing the output of new knowledge, and (iii) facilitate the dissemination of knowledge without undermining its appropriability. From the public policy standpoint, however, RJVs also pose certain risks. These are, first, a possible repression of overall investment in the production of new knowledge; second, a possible reduction in the number of independent approaches to technological challenges (caused, for example, by a stifling of entrepreneurial spirit under the bureaucratic weight of a joint venture); and third, a possible reduction in downstream market competition.

No single model can be designed to encompass all these conflicting facets in a tractable manner. Furthermore, different models of RJVs utilize different descriptions of R&D competition, with and without joint ventures in the downstream market. Consequently, the results generated from the models are somewhat specialized and their relevance for public policy is not yet fully understood. Nevertheless, some generalizations do emerge, as we shall see in section [B].

Ordover and Willig [1985] constructed a simple model of the economic effects of RJVs, focusing on the possible repression of R&D output. They model R&D competition as a game in which two firms make irreversible investments in generating new technology or products. The size of that investment determines when the new technology becomes available. In particular, firm i faces the (discounted) R&D cost of $C(t)/e_i$ associated with generating the innovation (or entering of the product market) by time t. Notice that with this setup, the Nash equilibrium may entail both firms' participating in the downstream market for all $t \geq t_D$, where t_D is the time at which the second firm enters with its innovation. The firm that innovates first enjoys a spell of monopoly profits, there being no possibilities for licensing. After t_D, there is competition in the downstream market, provided, of course, that $t_D < \infty$. Thus, rivalry between the two firms is treated as competition for (potentially transitory) monopoly profits.

When the two firms form an RJV they jointly decide on the time at which the innovation is to be realized, t_J. After t_J, the two firms competitively exploit the fruits of the joint R&D program. Social benefits from the joint venture will materialize, first of all, if $t_J < t_S$, where t_S is the earliest time at which the innovation would have taken place in the absence of an RJV. But even if $t_J > t_S$ society may benefit from the joint venture because with a joint venture there is no period of monopoly: Recall that after t_J both firms compete with each other using the new technology. It is easy to demonstrate that joint ventures will result in earlier innovation if there are cost efficiencies from a joint venture, i.e., if $e_J > \max e_i$, i=1,2, and the present discounted value of the sum of (gross) profits accruing to the joint venturers at t_S is not "too much" smaller than the profit of the firm that innovated earlier.

It is easy to conclude incorrectly that the profit condition could never be satisfied. As we discussed in Section 2, competition dissipates monopoly rents. However, in the market setting discussed here, the two potential co–venturers are not the only firms that can or will participate in the downstream market in the future. Consequently, in the model, the sum of the present discounted values of the "duopoly" profits can be even higher than the "monopoly" profits.[66] This could occur if the co–venturers are likely to face more strenuous competition in the downstream market from other firms than from each other.[67] The model indicates that even an RJV that acted to retard somewhat the earliest date of innovation would be likely to benefit consumers –– unless the co–venturers had a severe incentive to withdraw one of their products from the downstream market in order to reduce ex post competition.

Additional analytical complications ensue if the potential co–venturers already have products in the downstream market. Under this market scenario, each innovator must be concerned with the fact that a successful innovation could cause cannibalization of its preexisting flow of profits. It is not surprising that assessing the economic effects of RJVs becomes much more difficult in this richer setting. As it turns out, the desirability of an RJV depends critically on such factors as whether the co–venturers are motivated by "preemptive" or "defensive" considerations in making their R&D decisions and on whether the co–venturers are more or less "equally balanced" in the downstream market. Still, as a general conclusion, an RJV should be presumed to be in the social interest if the co–venturers' profits are highly sensitive to the competitive

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[66]Shapiro points out that in this case the leading firm might have licensed the patent, even in the absence of an RJV. However, if such a license were to have a positive usage fee, that fee would repress the use of the innovation below the level that would be realized had the RJV made licenses available at zero usage fees.

[67]As the analysis makes clear, the relevant point in time at which the level of downstream competition needs to be prospectively examined is the earliest Nash equilibrium innovation time in the absence of the RJV. See Ordover and Willig [1985], pp. 320–23.

constraints exercised by firms outside the RJV, so that, in a sense, the ultimate market power associated with the innovation is small. An RJV "should be viewed as a possible impediment to innovation if each firm has more to lose from the other's innovative advances than from falling behind the rest of the market or failing to jump ahead" (Ordover and Willig [1985], p. 330).

Katz [1986] provides a more detailed model of RJVs that focuses on the appropriability of knowledge and explicitly captures the effects of downstream competition on intra–RJV incentives to undertake R&D. Katz closely examines the process of RJV formation. First, his model allows firms to decide whether or not to join the venture. Upon joining, they decide how to share the costs and benefits of their research programs. After the joint venture is formed, all industry participants (those in the joint venture and those outside it) select their levels of R&D expenditure, taking as given the RJV's constitution and the levels of R&D chosen by their downstream rivals. Finally, firms make production decisions consistent with their production costs, which costs in turn depend directly on spillover parameters and on the overall level of R&D commitment in the industry.

It turns out that the characterization of the subgame perfect equilibrium of this four–stage game is far from trivial. Nevertheless, some important policy implications are generated by the model. Katz observes, for example, that the more competitive is the downstream market the greater is the danger that the industry–wide cooperative R&D will fall relative to the level that would be obtained in the absence of an RJV, (Katz [1986], p. 542). Here the intuitive explanation is straightforward: In the absence of cooperation at the R&D stage, each firm realizes that if it fails to keep up with its rivals in reducing costs, it will lose downstream market share (unless R&D spillovers are perfect). This spurs it to invest in R&D. In the cooperative setup, firms may select sharing rules and intra–RJV knowledge–sharing provisions that have the effect of retarding R&D expenditures (Katz [1986], Proposition 1). This result is bit unsettling because with intense downstream competition noncooperative levels of R&D are already likely to be less than socially optimal when there are spillovers.[68] However, when spillovers are significant, cooperative R&D can provide the incentives required for production of knowledge. In addition, cooperation is likely to increase the effective level of R&D output (defined as the aggregate R&D output available to a firm as an input in its own R&D activities) if it significantly increases within–group spillovers.[69]

The idealized models of RJVs we have so far examined abstract from the internal conflicts that often plague joint ventures. They also optimistically assume that the participants have no incentive to free–ride on each other. Yet it is clear that such incentives may exist. For example, in Katz's model every participant wants to withhold information from other co–venturers in order to minimize ex post spillover. In his model such efforts are easily detected because R&D output is linearly related to R&D input, which in turn is directly observable by all parties. If output is stochastic, however, it becomes possible to under–report R&D outputs and to withhold them from other members of the venture.[70] The incentives for such activities can be reduced considerably by requiring that all knowledge production be located in an independent

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[68]As d'Aspremont and Jacquemin [1987] show, allowing firms to cooperate in the downstream market may induce more R&D, especially when spillovers are large, potentially at the cost of lower downstream output. Welfare may still be up because of cost savings, although consumers are harmed. Whether competition policy can engage in such a trade–off is another question.

[69]Vonortas [1988] shows, in a simpler model than Katz's, that (in a two–firm industry) whether an industry's R&D and output are both increased after the formation of an RJV depends on whether basic research is a strategic complement or substitute across firms. Note in this context that even though in a Cournot model outputs are strategic substitutes, the presence of spillovers can cause basic research expenditures to be strategic complements.

[70]In two interesting papers, Bhattacharya, Glazer, and Sappington [1987a, 1987b] analyze the information–sharing in ventures from a formal game–theoretic perspective. Ordover and Shapiro [1985] discuss the issue in the context of the GM–Toyota joint venture.

organization owned or controlled by the partners. But, as Katz [1986] also points out, parallel R&D facilities can provide a check on the ability of RJVs to facilitate collusion.[71] The policy issues surrounding independent R&D facilities bring out a potential conflict between antitrust goals and the objectives of an RJV. From the standpoint of antitrust policy, co-venturers should have a right to carry out independent and parallel R&D efforts; however, the ability of an RJV to accomplish its objectives may be undermined if co-venturers begin to behave strategically toward it.

[B] **Antitrust Policy toward RJVs.**

Despite their simplicity, theoretical models of RJVs provide some guidance for the structuring of public policy toward joint ventures.[72] The models demonstrate that, in a broad variety of market settings, RJVs perform two desirable social functions. First, by reducing duplication and enhancing spillovers, RJVs reduce the social and private costs of generating a given amount of effective knowledge. Second, RJVs improve ex post dissemination through R&D output sharing arrangements, especially where effective licensing of knowledge is difficult to accomplish and RJVs entail less coordination than full-blown mergers. Consequently, antitrust policy ought to take a highly permissive stance toward them. Recent policy initiatives in the US and in the EC have moved strongly in that direction.[73] This is not to say that in the US, at least since (and even prior to) the passage of the National Cooperative Research Act of 1984,[74] antitrust decisions held against RJVs. We cannot discount the possibility that some socially desirable RJVs were simply not formed out of fear of antitrust intervention.

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[71]We have seen already that such facilities can also be a source of dissension among co-venturers.
[72]See, e.g., Grossman and Shapiro [1986], Katz [1986], and Ordover and Willig [1985]. Brodley [1982] offers a legal/economic analysis of joint ventures.
[73]See Jacquemin [1987] and Jacquemin and Spinoit [1985] for a discussion of the EC policies.
[74]5 U.S.C. 4301-4305

It is plain that RJVs should be encouraged because, even though they entail coordinated use of assets, they are less restrictive in asset use than are mergers, which may be the only other private alternative for remedying market failures in the production and dissemination of knowledge. Thus, while industry–wide mergers would not pass antitrust scrutiny (as least in the US), industry–wide RJVs do not automatically raise anticompetitive concerns.

This is not to say that RJVs should not be analyzed for their effects on present and future competition. The following lines of inquiry appear highly important. First, at the upstream level, the main query should be about the effects of an RJV on the current and future production of knowledge. As we have seen, in some circumstances RJVs can be used to repress or slow down the production and adoption of new technology. This is more likely if the RJV controls a large share of the assets that are critical to the production, dissemination, and adoption of new knowledge, and if the participants in the venture have more to fear from losing markets to each other than to firms that in the future would provide the needed downstream competitive constraint. In assessing the RJV's total share of the assets relevant to successful R&D, it is generally appropriate to take a global view of competitive interactions. Thus, while a particular RJV may include all major US or EC firms, it still may control only a small share of global pertinent R&D assets. In addition, even if the venture controls a large portion of the assets, its ability to repress technological progress may be weak if entry into the relevant upstream market is not very difficult. It seems that such entry is especially easy during the early stages of the evolution of the industry, when technological opportunities are still wide open and when the current assets are not key either to future R&D success or to successful exploitation of R&D output.

The second line of inquiry should focus on potentially anticompetitive effects of RJVs on downstream competition among the venture participants. In short, the less vertically integrated downstream is the venture, the less likely is it to be used to facilitate collusion in the product market. However, to the extent that unbridled downstream competition dissipates rents from successful R&D efforts, it may be necessary to allow RJV participants some restraints on ex post competition. Here the logic is not different from that which underlies the patent system. This is not to say that public policies should encourage perpetual collusion on the grounds that it creates the incentives required for investment in R&D. RJVs that are of only limited duration reduce the likelihood of prolonged collusion. And, in the end, new entry and incentives to cheat are likely to undermine the collusive outcome anyway. Thus, when the members of the joint venture slack off, new firms, which have no existing rents to protect, will take advantage of whatever technological opportunities were left unexploited by the members of the venture.

An additional danger of collusion is created when the members of an RJV compete in downstream markets that are only partly related to the activities covered by the venture. In these instances "Chinese walls" must be built in order to reduce the attendant risks.

Finally, RJVs ought to be scrutinized for their effects on excluded firms. Excluded firms will be placed at a relative disadvantage by the RJV in the downstream market whenever the RJV increases effective R&D to the co–venturers relative to outside firms.[75] As a result, outside firms may be forced to exit from the downstream market, reducing competition there. However, exclusion of a subset of competitors from an RJV is not in and of itself anticompetitive. It can be anticompetitive if it involves

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[75]Katz and Shapiro [1986] also point out that an RJV may issue fewer licenses than would an independent research lab, thus belying the notion that RJVs are conducive to dissemination. Their result does depend on the assumptions made as to the licensing mechanism that is likely to be adopted by the RJV and on the fact that the excluded firms cannot fend for themselves and set up a competing RJV.

a sacrifice of short–run benefits (such as those from better cost sharing and diffusion) for the sake of additional future profits.[76] Still, if the joint venture encompasses less than, say, a 60 percent share of the pertinent assets, exclusion should not be considered to create anticompetitive problems.

5. Mergers in High–Technology Industries

The issue of mergers in high–technology industries brings the Schumpeterian hypothesis into the sharpest relief. The hypothesis breaks down into three component parts: (1) Because of scale and scope economies in the production of knowledge, large firms are better suited to carry out R&D programs; (2) Presumably because of capital market failures, internal financing from current supracompetitive earnings is the best source of funds for future R&D; (3) The quest for future profits is the driving force behind investments in R&D, while future market dominance guarantees also that the adverse effects of spillovers on an innovating firm are diminished. Taken together, propositions (1) – (3) imply that "both market structure and R&D [must] be taken as endogeneous variables," (Levin and Reiss [1984], in Griliches [1984], p. 175). It must be stated at the outset that empirical support for these propositions is substantial but not fully conclusive.[77]

We shall not review the empirical evidence here. Rather, we shall briefly sketch some of the implications of the Schumpeterian view for public policy toward mergers in high–technology industries. It is clear that the Schumpeterian view calls for

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[76]Note in this connection that exclusion from an RJV does not necessarily raise excluded rivals' costs. Rather it causes the rivals' costs not to fall as much as they otherwise would, i.e., as they would if the excluded members were in the joint venture. Whereas rising rivals' costs may be an anticompetitive strategy, failing to lower rivals' costs can hardly be viewed as such. See Salop and Scheffman [1987] and Krattenmaker and Salop [1987] for anticompetitive strategies that raise rivals' costs.
[77]See Baldwin and Scott [1987].

a highly permissive public policy toward mergers in industries in which technological progress is the main driving force of competition.[78]

In organizing the analysis of mergers in high–technology industries, it is important to distinguish among three different types of assets that are brought into coordinated use by a merger.[79] At the most familiar level are the product–specific assets. These are the assets most directly related to the current market power, if any, of the merging firms. It is these assets that ought to be the focus of usual static analyses of horizontal mergers.

In high–technology industries, product–specific assets endow firms with only transitory market power. Of greater value and importance in the forensic analysis of mergers are market–specific assets. These assets are capable of generating rents that are less likely to be quickly eroded by endogeneous product and process innovations.

Finally, the third category of assets is R&D assets, including all those that are controlled or are likely to be controlled by the merging firms.

Let us see now how this tripartite classification of assets can be used in the analysis of the competitive effects of mergers in high–technology industries. To begin with, if the merging parties control a significant share of the relevant product–specific assets, this fact ought to raise the standard static concerns associated with mergers.

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[78]Reinganum [1988] surveys the implications in the reduction of the number of firms for the speed and intensity of R&D. Ordover and Willig [1985] explore the issue from the antitrust perspective.

[79]Ordover and Willig [1985] articulate the asset–based theory of mergers but do not model it rigorously. A recent paper by Farrell and Shapiro [1988] provides a rigorous static analysis of horizontal mergers in which assets in form of scarce productive capital are made explicit. Many standard theoretical analyses of the relationship between the number of firms and the pace of technological progress totally neglect the presence of any assets that are attached to those firms; alternatively they assume free entry into the technological race. When firms' assets are made explicit it is in the form of the existing market share held by these firms. See Reinganum [1988] for a thorough comparative statics and welfare analysis of changes in the number of firms on technological progress.

These concerns must be tempered, however, with the realization that in a high-technology industry such assets are not likely to provide a base for future rents. Product-specific assets controlled by the merging parties may include, for example, the installed base of a current (but rapidly aging) generation of computers, reprographic machines (as in the Xerox case), or patents that are rapidly nearing their economic (albeit not statutory) end. Whatever market power attaches to these assets, it is likely to be transitory unless the merger itself is likely to substantially slow the Schumpeterian process of "creative destruction." As we have noted earlier, there are some theoretical grounds for concluding that a firm with a significant share of product-specific assets may be reluctant to innovate rapidly for fear of cannibalizing its own rents. Consequently, a merger of two firms with substantial share of current product-specific assets may further reduce their incentives for innovation. This would be especially true if the two merging firms were the most direct competitive rivals in a technological race. It is also plausible that such a merger would place the merging parties at a strategic disadvantage, as described by Bresnahan [1985], by turning them into "fat cats." If these "fat cats" generate incremental rents through their post-merger coordinated use of assets, the effect will be to make the relevant product market even more attractive to future entrants.

Coordinated use of market-specific assets can have quite different consequences for R&D incentives and for future competition in the downstream market. First of all, command over a large share of market-specific assets need not significantly weaken incentives for investments in R&D. For example, assets such as reputation, customer lock-in into the products of the firm, distribution, service, etc., may remain valuable and be capable of generating future rents, even in a dynamic market environment. As a result, firms may be concerned less about cannibalization of their profits than about cases in which a substantial share of their rents would be dissipated by rapid advances.

Second, firms holding a substantial share of market–specific assets may be more capable of translating their R&D investments into downstream market share. In terms of competitive effects, this has both advantages and disadvantages. On the benefit side, coordinated use of market–specific assets may guarantee better utilization of the fruits of successful R&D programs. In considering costs, we find the possibility that increased concentration of such assets may perpetuate market concentration. This will be especially likely if effective utilization of R&D assets demands complementary market–specific assets. Indeed, casual empiricism suggests that small, venture–capital, R&D–intensive upstart firms often merge or form close alliances with bigger, more established firms. Such arrangements constitute a socially desirable method for agglomerating complementary assets. On balance, we judge that public policy should be more permissive of mergers of market–specific assets in high–technology industries. Such mergers are likely to produce dynamic efficiencies; also, even market–specific assets are apt to be short–lived in dynamic environments.

Not much needs to be said about how R&D assets should be treated for the purposes of merger analysis. It is plain that the analysis must first focus on the scale and scope efficiencies that could be obtained as a result of the merger. Second, the analysis should inquire into the degree of direct competition among the merging parties in terms of their present and likely future R&D projects. If the merging firms are direct head–on competitors, they may decide to repress their total expenditures after the merger. However, because a merger can permit perfect dissemination of the knowledge that will be created after the merger, total effective R&D needn't fall as a result. Thus, unlike the case of static losses due to the repression of output, the dynamic losses from repression of total R&D expenditures need not reduce social welfare. For this reason a more permissive treatment of mergers of R&D assets is warranted.

As this brief discussion suggests, the focus on various types of assets subject to a merger brings out the possible social gains and losses from mergers. In particular, it suggests that mergers in high–technology industries, in which technologies and products are short–lived, should raise fewer concerns than would similiar mergers in industries that have entered their stable phase. This suggestion holds as long as high–technology mergers do not combine firms with large shares of substitute R&D assets that also require large shares of market–specific assets for their effective exploitation.

6. Concluding Comment.

The unavoidably complex and sometimes imperfectly conclusive character of the preceding deliberations may obscure the fundamental point, emphasized in the introduction to this paper: the key role of the trade–off between static and dynamic efficiency. We have emphasized that conflict between the two is less pervasive than is sometimes supposed. Thus, we believe that, often, eliminating some of the more arbitrary elements of traditional antitrust intervention can serve both static and dynamic efficiency.

However, where the two desiderata are unavoidably at loggerheads, it is generally our predisposition (as is evident from the discussion of this paper) to favor the long–run goals over those of the short run. The reason is clear, and rests on the powers of compounding. If an increment in growth, even a small one, can be sustained indefinitely, it must ultimately overcome any static loss that its generation has required. It is not static efficiency but dynamic performance that has accounted for the historically unparalleled record of the world's industrialized economies in the past two centuries. It is this performance that for the first time in human history has transformed, for the bulk of the population, an existence governed by the chronic fear of grinding poverty and literal starvation into a way of life in which, ironically, the disposal of surplus capacity and surplus outputs is viewed as the most pressing and chronic problem. Policy design should, in our view, base its priorities on the demonstrated significance of the long run.

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