AFTERMARKETS AND CONSUMER WELFARE: MAKING SENSE OF *KODAK*

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I. INTRODUCTION

The Supreme Court, in *Eastman Kodak Co. v. Image Technical Services, Inc.*,[1] ruled that a manufacturer could, as a matter of law, have monopoly power in the servicing of its own equipment, even if it had no such power in the sale of that equipment. In other words, aftermarkets could be relevant antitrust markets, even if equipment markets are competitive. The Court thus concluded that Kodak's refusal to sell its proprietary spare parts to independent service organizations (ISOs) could, at least in theory, allow Kodak to control the aftermarket for the servicing of Kodak equipment, thereby using its control over Kodak *parts* to gain control over the *servicing* of Kodak machines.

The *Kodak* decision has already received an enormous amount of attention, both by economists and by lawyers, and rightly so.[2] To the economist, *Kodak* raises fascinating and thorny issues, both theoretical and practical.[3] For the antitrust lawyer, the reach of the *Kodak* decision

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[1] 112 S. Ct. 2072 (1992).

[2] *See, e.g.*, Joseph Kattan, *Market Power in the Presence of an Installed Base*, 62 ANTITRUST L.J. 1 (1993); Carl Shapiro & David Teece, *Systems Competition and Aftermarkets: An Economic Analysis of* Kodak, 39 ANTITRUST BULL. 135 (1994); Benjamin Klein, *Market Power in Antitrust: Economic Analysis After* Kodak, 3 SUP. CT. ECON. REV. 43 (1993) Severin Borenstein, Jeffrey MacKie-Mason & Janet Netz, Exercising Market Power in Proprietary Aftermarkets (unpublished manuscript 1994). These are but a few of the many articles in legal and economic journals that explore the *Kodak* decision and its implications. I do not even attempt here to delve into the various legal cases that cite *Kodak* or involve aftermarkets.

[3] I certainly have found *Kodak* to touch on many important and difficult economic issues. Some of these I explored in my article with David Teece, *supra* note 2. This article complements that article. There we focused on the question of assessing market power in aftermarkets, and we explained how the economics literature informs that task. Here I offer

is great indeed, as it markedly expands the number of companies that may be regarded as "monopolists."

Kodak has also been put forward as the preeminent example of so-called "Post-Chicago Economics."[4] If "Post-Chicago Economics" stands for the notion that markets are subject to numerous imperfections, as indeed the Court recognized in *Kodak*, let me be counted in the "Post-Chicago" camp. However, if "Post-Chicago Economics" stands for the notion that courts are capable of fine-tuning firms' behavior in competitive markets, or that antitrust should move away from promoting efficiency and consumer welfare,[5] count me out. In what follows, I will show that *Kodak* holds considerable dangers of restraining the behavior of firms that possess no genuine monopoly power.

The Court's decision in *Kodak* has directed the attention of the antitrust community towards certain economic issues of long-standing interest to economists. One reason *Kodak* has attracted so much attention is that the Court incorporated in its opinion economic thinking of the past fifteen years in a way not often seen before. Let me cite three examples.

First, the Court discussed the economics of reputation, exploring whether a firm would find it profitable to run down its reputation by taking advantage of some of its more vulnerable customers, i.e., by engaging in installed-base opportunism.[6] Second, the Court explored the issue of consumer switching costs, took explicit notice that some customers might be "locked in" to certain products, and recognized that sophisticated contracts could to some degree protect these consumers

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a step-by-step framework organizing the economic analysis of antitrust claims involving aftermarkets. I also report new research here suggesting that monopolization of aftermarkets in the presence of equipment competition is likely to cause far less consumer injury than traditional monopoly power. Finally, I argue that the *Kodak* decision may end up having a more chilling effect on certain business practices than appeared likely even a year ago.

[4] Steven Salop linked the *Kodak* decision with a "Post-Chicago" movement, in *Kodak* as Post-Chicago Law and Economics (Jan. 1993) (unpublished manuscript). The *Kodak* decision was a focus of the conference on "Post-Chicago Economics," of which this article was a part.

[5] See Eleanor Fox, Eastman Kodak Company v. Image Technical Services, Inc.—*Information Failure as Soul or Hook?* 62 ANTITRUST L.J. 759 (1994), for a discussion of the view that the information failures discussed by the majority in *Kodak* were in fact a pretense, the Court being more interested in protecting worthy small businesses than in promoting efficiency as such. "*Kodak* is essentially a case about abusing competitors; it is not essentially a case about lack of consumer information." *Id.* at 767.

[6] Some of the basic trade-offs involved in the economics of reputation are discussed in Carl Shapiro, *Premiums for High-Quality Products as Returns to Reputation*, 98 Q.J. ECON. 659 (1983).

from being gouged.[7] Third, the Court recognized that market boundaries may be strongly affected by compatibility, i.e., the ability of various components to work together.[8] Aftermarket problems are most likely to arise with incompatible components, giving rise to proprietary aftermarkets.

In this article, I offer a systematic economic framework for analyzing antitrust cases involving aftermarkets. This framework is quite powerful, both for understanding the arguments that arise in aftermarket cases, and for identifying the questions that must be asked to define markets and evaluate competitive effects of various business practices when proprietary aftermarkets are involved. My framework is structured around the four available theories of antitrust injury involving aftermarket practices. All in all, I conclude that significant or long-lived consumer injury based on monopolized aftermarkets is likely to be rare, especially if equipment markets are competitive.

I also present here a new, in-depth analysis suggesting that any consumer injury arising when a single firm controls its own proprietary aftermarkets is likely to be small, even if one accepts the theories put forward by those concerned about aftermarket power. The reason is that equipment market competition will tend to "rebate" any aftermarket overcharges to buyers in the form of equipment discounts. This general idea is well-known, but I develop a formal model in the Appendix to this article, making it possible to quantify this concept.

Finally, I report here on some recent consumer class actions spawned by the *Kodak* decision. It seems that the *Kodak* decision will successfully be used by plaintiffs in many antitrust actions, at least to obtain class certification, even if the theories put forward by these plaintiffs bear no resemblance to, or even contradict, the theories endorsed by the Supreme Court in *Kodak*. I also make some remarks about remedies in *Kodak*-style cases.

II. AN ECONOMIC FRAMEWORK FOR STUDYING AFTERMARKETS

Very often, consumers make investments in capital equipment that requires maintenance, repair, upgrades, and other complementary prod-

[7] There is a long literature on contracts, opportunism, and lock-in, associated most prominently with Oliver Williamson. *See, e.g.*, OLIVER WILLIAMSON, THE ECONOMIC INSTITUTIONS OF CAPITALISM (1985); *see also* Joseph Farrell & Carl Shapiro, *Optimal Contracts with Lock-In*, 79 AM. ECON. REV. 51 (1989).

[8] Economists have paid close attention lately to the economics of compatibility, and specifically to the *network externalities* that arise when many consumers use compatible components. *See, e.g.*, Michael Katz & Carl Shapiro, *Systems Competition and Network Effects*,

ucts and services. Kodak's customers buy high-volume copiers, for which they require suitable replacement parts and service by technicians capable of repairing Kodak brand copiers. This pattern is common for sophisticated equipment, as well as for hardware/software systems. For example, a consumer buying a Nintendo video game machine subsequently seeks to buy game cartridges compatible with the Nintendo machine, and a customer familiar with Microsoft's Word for Windows will find it easier to learn an upgrade to Word rather than learning a whole new word processing program. In all of these cases, a consumer, having chosen a specific brand at one point in time, may find it costly to switch later to other brands. That is the essence of an aftermarket.

There are three key elements to an aftermarket: (1) the consumer purchases several (complementary) components that work together as a "system" to provide value to the customer; (2) these components are purchased at different points in time; and (3) there is some degree of "lock-in" or sunk costs, i.e., at least some of the expenditures on the initial component(s) cannot be recovered if the consumer later switches brands. In the case of high-volume copiers, the initial component is the machine itself, and the components purchased later are spare parts and service to keep that machine operating properly.[9]

In this article, following the Court, I will refer to the primary market as the "equipment market," leaving spare parts, service, or repair as the aftermarkets. But the foremarket/aftermarket pattern is far more general than this. It includes computer hardware and software, any situation where consumers buy one piece of equipment and then consumables for that equipment (a common situation for medical equipment), or even one piece of equipment (or one copy of a computer program) and then later more of the same equipment (e.g., after the customers has learned to use that equipment or program). Suffice it to say that aftermarkets are ubiquitous.

Since aftermarkets are so widespread, and involve a substantial volume of commerce, it is not surprising that the *Kodak* decision has spawned a large number of cases. Indeed, we are in the midst of a wave of cases encouraged and inspired by *Kodak*. These involve such industries as high-volume copiers and printers, medical equipment, operating systems for sophisticated manufacturing facilities, minicomputers, and telecom-

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8 J. ECON. PERSP. 93 (1994); Stanley Besen & Joseph Farrell, *Choosing How to Compete: Strategies and Tactics in Standardization*, 8 J. ECON. PERSP. 117 (1994).

[9] I discuss below the possibility that consumers may choose to purchase more than one component at the outset, thereby shifting some purchases from aftermarkets into the overall systems market.

munications equipment. Some of the larger monetary claims involve class actions brought on the behalf of customers buying equipment from companies that are alleged to have monopolized proprietary aftermarkets for the servicing of their equipment, or upgrades to that equipment. Some of these cases, while citing *Kodak*, have strayed very far indeed from the theories put forward by the Supreme Court in *Kodak*.

Economics currently offers four theories of aftermarket power:

(1) *The "Surprise" Theory.* The equipment manufacturer can engage in ex post exploitation of locked-in buyers, also called installed-based opportunism, by making unexpected changes in aftermarket policies that exclude aftermarket rivals and thus allow the manufacturer to extract more money from locked-in buyers who have already purchased its equipment.

(2) *The "Costly Information" Theory.* There are a large number of myopic or poorly informed buyers who fail to account for aftermarket costs when purchasing equipment. Since these equipment buyers are not frightened away by monopolistic aftermarket prices, equipment competition creates little or no incentive for manufacturers to offer service at competitive prices. To the contrary, manufacturers have every incentive to extract the greatest profits possible from their installed base. In other words, costly information severs or at least weakens the link between aftermarkets and equipment markets, permitting a firm in a competitive equipment market to have aftermarket power.

(3) *The "Limited Manufacturer Commitment" Theory.*[10] The equipment manufacturer has limited ability, at the time a customer buys equipment, to make credible and binding price and quality commitments for aftermarket service. As a result, the manufacturer inevitably takes advantage of customers in the aftermarket, at least to some degree, if not prevented from doing so by aftermarket competition. Thus, aftermarket competition provides added protection for consumers, even if equipment markets are highly competitive.

(4) *The "Price Discrimination" Theory.* A firm with market power in the systems market, i.e., the overall interbrand market for equipment and

[10] The "Limited Manufacturer Commitment" Theory is emphasized by Severin Borenstein, Jeffrey MacKie-Mason & Janet Netz, *Antitrust Policy in Aftermarkets*, *supra* this issue, 63 ANTITRUST L.J. 455 (1995). As I explain below, this theory has essentially the same implications for consumers as does the Costly Information Theory. I include the "Limited Manufacturer Commitment" Theory here partly for the sake of clarity, to show how my analysis relates to that of Borenstein, MacKie-Mason, and Netz, and partly because the formal model developed in the Appendix relates specifically to the issue of consumer injury with competitive equipment markets and monopolized aftermarkets.

service together, can price discriminate more effectively in the sale of its system if it can separately control the prices of parts and service for its equipment. Exclusion of aftermarket rivals therefore can be profitable by permitting such enhanced price discrimination by the manufacturer.[11]

I analyze each of these four theories in turn.

A. The "Surprise" Theory

The surprise theory starts from the assumption that buyers in the aftermarket are vulnerable, and asks whether the equipment manufacturer will find it profitable to unexpectedly change its policies so as to exploit them. The firm that takes advantage of its installed base of customers who find it costly to switch to other brands is said to engage in installed-base opportunism.

It should be noted from the outset that any consumer injury associated with the surprise theory will tend to be short-lived, typically confined to the cohort of consumers who owned equipment when the manufacturer made its policies more restrictive or somehow less favorable to customers or aftermarket rivals. Under the surprise theory, antitrust injury would occur if buyers had anticipated or relied on competitive aftermarkets, but some change in the manufacturers' policies blocked that competition.[12]

1. *Contractual Protections and Installed-Base Opportunism*

Buyers have strong incentives to obtain contractual protections when purchasing their equipment, precisely to prevent the manufacturer from exploiting them later in a proprietary aftermarket. These protections may take a number of forms:

(1) Warranty Coverage. By obtaining warranty coverage, the buyer contracts for some service when the equipment is purchased, prior to any lock-in.

(2) Rental or Lease of Equipment. By renting or leasing equipment, again the "system" (equipment, replacement parts, and service) is bundled, and the buyer avoids having to negotiate with the seller from a position of weakness.

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[11] Unlike the previous three theories, the "price discrimination" theory does not apply to a firm operating in a competitive equipment market. However, it could apply, in weakened form, to a firm with some market power in the equipment market even if that market power falls short of true monopoly power.

[12] A variation not involving any "surprise" occurs if buyers had expected to pay supracompetitive aftermarket prices, and the manufacturer changed its policies to prevent unanticipated aftermarket competition from taking hold. In this case, buyers might indeed have benefited from aftermarket competition, but even in the absence of that competition they would pay no more than competitive prices for their equipment and service together.

(3) Long-Term Service Contracts: Buyers frequently obtain long-term service contracts concurrently with equipment; this is the norm in the high-volume copier market in which Kodak participates. Again, parts and service purchases are moved out of the aftermarket and into the foremarket, where the buyer has more choices.

(4) Nondiscrimination Clauses. A buyer can gain some protection by obtaining a contractual commitment from the seller that the buyer will receive the same terms and conditions for aftermarket services as are offered to new customers.

(5) Second Sourcing and Open Systems. A buyer can gain substantial protection if the manufacturer makes a commitment to support or at least allow independent sources of aftermarket services to develop, or if the manufacturer agrees to adhere to certain industry standards, ensuring that the manufacturer will not be the only source of proprietary parts or upgrades.

Warranty coverage, rental and lease arrangements, and long-term service contracts all serve the function of shifting buyers' purchases from the aftermarket to the systems market. Thus, they diminish the importance of the aftermarket and any scope for consumer injury from aftermarket practices and policies. Nondiscrimination clauses, second sourcing provisions, and commitments to open systems all reduce the manufacturer's ability to engage in installed-base opportunism. However, it must be recognized that these contractual protections typically do not entirely eliminate the possibility of installed-base opportunism, since it is quite difficult for buyers to obtain ironclad protection by writing a "complete" contract that specifies all relevant aftermarket terms and conditions.

Any analysis of installed-base opportunism must account for any explicit contractual protections obtained by customers. If most customers are so protected, any antitrust injury will be limited to a minority of consumers.

2. *The Surprise Theory and the Economics of Reputation*

Even if buyers are well informed, they can still be exploited in the aftermarket if they lack the explicit contractual protections mentioned above. No doubt some customers are vulnerable to such exploitation, at least for the short term. The Court correctly identified some of the factors that would influence a firm's decision to exploit its installed base of customers.

Whether a manufacturer finds it profitable to engage in such installed-based opportunism is a classic problem in the economics of reputation:

Can the manufacturer earn greater profits by preserving its reputation for serving its customers well or by running down its reputation by exploiting its installed base?[13]

Economics has much to say about installed-base opportunism. First, a manufacturer's ability to exploit any given customer cannot exceed (in present-value terms) that customer's brand-switching costs, i.e., the extra cost that consumer would incur in replacing its system with a rival vendor's system.[14] Brand-switching costs vary across buyers, and with the age and vintage of their equipment, so a firm attempting to charge "monopoly" prices in its own aftermarkets will inevitably face some elasticity of demand as customers with relatively low switching costs will indeed switch brands in response to higher aftermarket charges.

A manufacturer will find installed-base opportunism less attractive, the greater is the growth rate of the market, the greater are its prospects to gain market share, the greater is the margin on its overall system, and the stronger are the linkages between current aftermarket policies and future equipment sales. Installed-base opportunism is most likely to be attractive for a firm that is exiting the market, or in a sharply declining market.[15] The damage to a manufacturer's reputation associated with installed-base opportunism need not be limited to the product in question. If a firm's actions undermine customers' trust in the firm, or alter customers' expectations about how the firm will behave in the future, there is nothing confining the harm to the firm's reputation to a single product market. Would you be happy going to a mechanic who was known to overcharge for truck repairs, merely because you have a car, not a truck, in need of repair?

In practice, the key question at trial may not be whether the manufacturer could have gained by engaging in installed-base opportunism, as calculated based on market growth rates or profits margins. A simpler

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[13] *See* Shapiro, *supra* note 6.

[14] The mere fact that a customer has purchased a piece of capital equipment does *not* in and of itself imply that the brand-switching costs are large. If the used-equipment market functions well, and if the buyer has made no investments in complementary assets, the brand-switching costs may be low. The buyer simply sells the old equipment and replaces it with another brand of equipment. However, transactions costs in used-equipment markets can be high, due in part to asymmetric information about the condition of used equipment (the famous "lemons" adverse selection problem, which partially accounts for the fact that nearly new equipment often sells for far less than brand-new equipment) and in part to the fact that used-equipment markets may be thin.

[15] It is not a coincidence that several aftermarket cases involve the declining minicomputer market. Virtual Maintenance, Inc. v. Prime Computer, Inc., 957 F.2d 1318 (6th Cir.), *vacated,* 113 S. Ct. 314 (1992); HyPoint Technology, Inc. v. Hewlett-Packard Co., 949 F.2d 874 (6th Cir. 1991).

question may be more important: Did or did not the manufacturer in fact change its policies in a way adverse to locked-in customers and aftermarket rivals? If so, did the manufacturer in fact raise any of its aftermarket prices at the same time or soon thereafter, or did policy changes reasonably serve a legitimate business purpose?

3. *Will the* Kodak *Decision Protect Buyers from Installed-Base Opportunism?*

Suppose that the market conditions make installed-base opportunism both possible and profitable. To illustrate, suppose that the market is declining, the firm sells no other comparable equipment where its reputation may suffer, the firm in question truly controls a key aftermarket input (such as spare parts), and many customers lack explicit contractual protections. Even in this situation, it is far from clear that an antitrust duty to sell spare parts to independent service organizations will do much to protect consumers, if indeed the manufacturer wants to engage in opportunism. After all, there is nothing to prevent the manufacturer from simply raising the price of the parts it controls, whether or not it sells those parts to independent service organizations. Raising parts prices to monopoly levels is a straightforward way to engage in installed-based opportunism, without risking antitrust exposure, if that is the manufacturer's intent.

The important point here is that installed-base opportunism and exclusion of ISOs can easily be de-coupled: exclusion is not necessary to exploit the installed base, nor does it imply that the firm is engaging in opportunism. In fact, the manufacturer controlling spare parts can positively benefit from the entry of more efficient service providers, whether or not it is engaging in installed-based opportunism, since it can capture its profits in the form of markups on its proprietary parts. This argument suggests that a refusal to deal may be motivated by other concerns, e.g., the manufacturer's concern about protecting its reputation.

Furthermore, imposing a duty to deal on the manufacturer might well harm consumers. Partial protections for buyers, based on antitrust law, may be worse than no protections at all, an admittedly surprising concept that Joseph Farrell and I have called the "Principle of Negative Protection."[16] Ultimately, interbrand competition, contractual protections, and

[16] This finding has an intuitive basis. The point is this: If the antitrust laws force the manufacturer to act inefficiently in aftermarkets, ultimately consumers will have to pay for these inefficiencies, leading to consumer harm. *See* Joseph Farrell & Carl Shapiro, *supra* note 7; *see also* Zhiqi Chen & Thomas Ross, *Refusals to Deal, Price Discrimination and Independent Service Organizations*, 2 J. ECON. & MGMT. STRATEGY 593 (finding a similar result, based on a reduction in product quality motivated by a legal duty to deal).

manufacturer commitments, and the manufacturer's reputation are likely to be far stronger forces protecting buyers than will be a legal duty to deal with its aftermarket rivals.

Finally, one might well ask what constitutes a "surprise," in the context of the Surprise Theory. Very often, firms implement policies in specific ways that could not have been foreseen either by them or by their customers. Is any change in policy or new implementation of policy that might adversely impact aftermarket rivals a "surprise," and subject to antitrust challenge, even for a firm in a competitive equipment market? Clearly, interbrand competition may be stifled and buyers may be hurt if manufacturers have little flexibility in setting and implementing their aftermarket policies. What constitutes a "change" in policy, and what is a reasonable adjustment to changing market conditions, remain to be determined.

Economics tells us that only under certain limited circumstances (discussed above) can manufacturers in competitive equipment markets profitably harm consumers by changing their policies with regard to the sale of replacement parts to independent service organizations, or by tying parts and service, in comparison with simply pricing their key replacement parts to maximize profits. This being the case, and since consumer injury under the Surprise Theory is naturally limited in time, it is fair to ask whether consumers ultimately stand to benefit from the *Kodak* decision, even accepting the basic theoretical point that in some circumstances a manufacturer might make the highest profit by engaging in opportunistic behavior. One can also ask whether this type of consumer injury, which tends to be short-lived by its nature, is of the sort that requires treble damages protection, instead of the single damages available under contract law. After all, antitrust law is slow-working and a rather blunt instrument, while installed-base opportunism is by definition a short-run strategy.

B. THE "COSTLY INFORMATION" THEORY

The Costly Information Theory applies in equipment markets in which buyers are relatively poorly informed, especially as regards the aftermarket costs associated with various brands of equipment. Surely there are markets in which information about life-cycle costs is sufficiently costly that many buyers make their equipment purchases with poor information about aftermarket costs. Perhaps automobile markets fit this pattern. If most buyers are ignorant of aftermarket costs when buying equipment, it is true that equipment competition might do little to ensure that buyers receive competitive prices in aftermarkets. However, as I discuss below, equipment competition *still* offers substantial protection for consumers, even if they are poorly informed or myopic.

1. *The Costly Information Theory and the Total Cost of Ownership (TCO)*

Before exploring the implications of poor buyer information, it should be recognized that the circumstances in which there is a significant market failure based on poor buyer information may not be all that common. Buyers have strong incentives to purchase equipment based upon the total cost of ownership of the equipment over its lifetime. The Costly Information Theory can only apply if the cost to buyers of obtaining TCO information is high relative to the savings available to informed buyers.

Information costs are lowered by: (1) third-party sources of information such as consultants, brokers, and publications; (2) buyers' ability to spread information costs over multiple units; (3) repeat buyers who have experience with life-cycle costs. In many situations where expensive equipment is being financed, the financing entity requires a pro forma life-cycle cost analysis for the piece of equipment prior to providing financing.

The Costly Information Theory is unlikely to apply for expensive equipment. Likewise, the Costly Information Theory will be very difficult to sustain in markets where buyers are large and/or experienced. Indeed, it is ironic that in the market for high-volume copiers, in which Kodak competes, there is compelling evidence that most buyers do indeed make their purchase decisions based on the total cost of ownership.[17]

In any event, it is not necessary for all consumers to have good information in order for aftermarket prices to be disciplined by equipment competition. Poorly informed buyers may be protected by informed buyers, whose presence forces sellers to compete on a TCO basis and penalizes sellers with high aftermarket charges, especially since it may be difficult for sellers to identify the poorly informed buyers so as to price discriminate against them.

2. *Systems Competition in the Presence of Costly Information*

Even in the relatively rare case where the bulk of the buyers are poorly informed about life-cycle cost—e.g., if information costs are uniformly high relative to the cost of a system—systems competition will still tend to prevent manufacturers from earning monopoly profits. The key point is that sellers are surely aware of the life-cycle profits associated with selling a piece of equipment, even if buyers are poorly informed about

[17] I have studied this market as an expert for Xerox and for Kodak. Indeed, in end-user class actions against both of these companies, the plaintiffs and their economic expert conceded that buyers typically purchased high-volume copiers on a TCO basis.

aftermarket costs. Therefore, systems competition pushes manufacturers to discount their equipment to capture any aftermarket "monopoly" profits.[18]

This is a very compelling economic argument, and one that goes a long way toward showing that substantial ongoing consumer injury from exclusionary aftermarket policies is unlikely to occur in competitive equipment markets, even if consumer information is poor. The Court instructs us that the facts must be marshalled to show that equipment suppliers truly do consider the total return on a system when pricing equipment; I would expect this to be the typical case. The idea of giving away the razor to make money on sales of razor blades is just too obvious, and intuitive, for companies to miss it. Again there is irony here: Kodak (like Xerox) very clearly evaluates the total return on the sale of a high-volume copier, including anticipated aftermarket revenues, when selling its copiers. Any company that does not account for aftermarket revenues and costs when selling its equipment should be seriously questioned by its shareholders, quite apart from any antitrust exposure.

3. *Consumer Injury from Costly Information Tends to Be Limited*

This powerful observation naturally leads to the following question: How do consumers fare if aftermarket prices are supracompetitive and equipment prices are subcompetitive?[19] Under this outcome, the suppliers who sell their equipment in a competitive market earn only competitive rates of return overall on equipment and service. There are no monopoly profits in this situation, and consumer injury is limited to the inefficiency (economic deadweight loss) caused when prices depart from costs on a component-by-component basis. Consumer injury in this context consists only of a "deadweight-loss triangle." Unlike traditional cases, consumer injury in aftermarkets does not include any "monopoly profits rectangle" (which usually represents the monopoly overcharges and forms the basis of customer injury claims in monopolization cases) because that rectangle is "rebated" to consumers in the form of equipment discounting.

So, if the Costly Information Theory applies, the injury against which the antitrust laws are protecting consumers is quite different from the

[18] This does not mean that equipment is sold below cost. It merely means that the rate of return earned on equipment sales is below a competitive level, while the rate of return earned on aftermarket sales is above the competitive level, so that the suppliers overall earn a competitive rate of return. Of course, to the extent that equipment and service are sold together, as when equipment is leased and the lease includes service, one cannot even define these separate rates of return and there is no aftermarket transaction to begin with.

[19] Again, prices cannot even be defined for equipment and distinct from aftermarket service in situations where consumers purchase equipment and service together.

usual monopoly overcharges, and certainly does not appear in the form of monopoly profits. The injury is entirely due to "inefficient substitution" as consumers substitute relatively inexpensive equipment for relatively expensive service in assembling a system. This involves consumers replacing their equipment prematurely, both because the equipment is discounted below a competitive level and because service is priced supracompetitively (and older machines require more service). In the following section, I offer a detailed formal model showing that this type of consumer injury should generally be far less of a concern than traditional monopoly power.

Furthermore, manufacturers in a competitive equipment market have incentives to avoid even this inefficiency by providing information to consumers. A manufacturer could capture profits by raising its equipment prices above market levels (i.e., closer to cost), lowering its aftermarket prices below market levels (i.e., closer to cost), and informing buyers that its overall systems price is at or below market. In this fashion, the manufacturer could eliminate some or all of the deadweight loss, attract consumers by offering a lower total cost of ownership, and still capture as profits some of the eliminated deadweight loss. In other words, and unlike traditional monopoly power, the manufacturers have a direct incentive to eliminate even the small inefficiency caused by poor consumer information.

C. THE "LIMITED MANUFACTURER COMMITMENT" THEORY

The Limited Manufacturer Commitment Theory is developed in some detail in the article by Borenstein, MacKie-Mason, and Netz.[20] The basic idea is that manufacturers cannot commit to competitive aftermarket prices, due to imperfections in the contracting process, and thus will inevitably be tempted to raise aftermarket prices at least somewhat above competitive levels to take advantage of locked-in customers.

It is important to distinguish the Limited Manufacturer Commitment Theory from the Surprise Theory. The Limited Manufacturer Commitment Theory applies on an ongoing basis; it is a steady-state theory, not a theory based on transition. Aftermarket prices are fully anticipated by buyers; there is no surprise. Manufacturers balance the short-run gain from setting high aftermarket prices against the need to offer somewhat lower equipment prices in the future to continue to attract new customers. As Borenstein, MacKie-Mason, and Netz correctly point out, since

[20] Borenstein et al., *supra* note 10.

the reputation mechanism does not work perfectly,[21] the steady-state outcome is for aftermarket prices to be somewhat above competitive levels, and equipment prices to be somewhat below competitive levels.[22]

1. *Nimble Antitrust Law vs. Contractual Remedy*

I find this a difficult theory on which to hang antitrust policy. The essential policy assumption is that manufacturers are unable to make commitments to their customers regarding aftermarket terms and conditions, but that antitrust law can remedy this market failure. I have some trouble accepting the view that the antitrust laws can effectively provide protections for consumers where manufacturers cannot through contract. Antitrust law is not a nimble policy instrument for fine-tuning relationships between manufacturers and customers in ways that contracts cannot.

What precisely is antitrust law supposed to do that private contracts cannot? The answer must be "ensure competitive aftermarkets." However, manufacturers clearly can make such commitments, at least in the general terms that antitrust law might guarantee. A manufacturer can promise for some period of time not to change certain of its policies, such as its policy to sell replacement parts to ISOs on the same terms as they are sold to final customers. Or a manufacturer can promise to support open systems or second sources for service or software upgrades. Protections like these are sought by some customers and offered by some sellers in the real world. Of course, contractual remedies are not perfect, but they are certainly workable and far more flexible than antitrust law. Ultimately, antitrust law seems a poor instrument to try to correct for the fact that contracts are imperfect.

As noted above, the Limited Manufacturer Commitment Theory implies that each manufacturer has the incentive to try to offer stronger commitments to customers than do other firms, and thus eliminate the deadweight loss, gain market share, and raise profits. In fact, competition should favor those manufacturers that can design more effective contracts, or that have a greater reputation to put on the line (because they sell more products or are especially well regarded), further reducing any remaining inefficiency from contractual and reputational imperfections. Are we to believe that such a manufacturer positively needs the antitrust laws to make those commitments?

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[21] See Carl Shapiro, *Consumer Information, Product Quality, and Seller Reputation*, 13 BELL J. ECON. 20 (1982), for a general demonstration that the reputation mechanism is an imperfect substitute for contractual protections.

[22] The size of the gap between aftermarket prices and costs depends on the factors discussed earlier, such as the growth rate of the market, interest rates, etc.

2. *Second-Order Antitrust Law*

Leaving aside these major issues, let me turn to a direct evaluation of the harm to consumers that can arise when equipment markets are competitive and aftermarkets are monopolized. For the purposes of assessing consumer welfare, the Limited Manufacturer Commitment Theory is nearly identical to the Costly Information Theory: in either case, consumers face supracompetitive aftermarket prices and subcompetitive equipment prices.[23]

As noted above, consumer injury in this situation is confined to the deadweight loss/inefficiency caused by the departure of equipment and service prices from costs on a component-by-component basis. As explained by Borenstein, MacKie-Mason, and Netz, this inefficiency is largely due to the premature replacement of equipment by customers.

I am not convinced that this type of consumer injury is worthy of the attention of the antitrust laws. This injury tends to be far smaller than traditional monopoly overcharges and deadweight losses. I am skeptical that good antitrust policy requires the courts to be involved in regulating the conduct of businesses unless significant consumer injury or inefficiency is involved.

I have developed a rather detailed formal economic model to show that consumer injury from monopolized aftermarkets, in competitive equipment markets, tends to be far smaller than the consumer injury associated with traditional monopoly overcharges. The analysis, which is presented in the Appendix to this article, shows that, even if one takes models such as that offered by Borenstein, MacKie-Mason, and Netz on their own terms, including their assumption that firms cannot make commitments to aftermarket terms and conditions when equipment is sold, it is far from clear that monopoly control of proprietary aftermarkets is a problem worthy of antitrust attention, at least as measured by potential consumer injury.

More specifically, in the Appendix I calculate what I call the "Injury Ratio," as follows. Consider the impact on consumers of a price increase for aftermarket services. Ignoring equipment competition, suppose this price increase would harm consumers by $100. Suppose that accounting

[23] In fact, the Limited Manufacturer Commitment Theory predicts significantly smaller consumer injury than does the Costly Information Theory. Under the Limited Manufacturer Commitment Theory, aftermarket prices are well below monopoly levels, if somewhat higher than competitive levels, because the reputation mechanism keeps aftermarket prices down, albeit not all the way down to competitive levels. In contrast, under the Costly Information Theory (at least its strong form), aftermarket prices are at "monopoly" levels, i.e., the level that a firm would set without regard to any future equipment sales.

for equipment competition (i.e., accounting for the fact that higher aftermarket prices would lead to lower equipment prices), the overall injury to consumers is only $25. Then I would say that the Injury Ratio is 25 percent. The Injury Ratio is a measure of how much less we should worry about aftermarket monopoly, compared with traditional monopoly power, if we adopt a consumer-welfare viewpoint.

In the Appendix to this article, I show that the Injury Ratio is approximately zero if aftermarket prices are close to cost before they are increased. In the specific example shown at the end of the Appendix, if aftermarket prices are 5 percent above cost, the Injury Ratio is 7.5 percent, i.e., 92.5 percent of the aftermarket overcharges associated with further increases in aftermarket prices are rebated to consumers in the form of equipment discounts. Under the Limited Manufacturer Commitment Theory, aftermarket prices are held somewhat close to cost by reputation effects, making this result very significant. Even taken on its own terms, this theory does not lead to significant consumer injury.

More generally, equation (9) in the Appendix provides a (complex) formula for the Injury Ratio. If aftermarket prices are 10 percent above cost, in my example I find that the Injury Ratio is about 14 percent, so 86 percent of the potential aftermarket injury is alleviated through equipment competition. Even under the Costly Information Theory, therefore, any consumer injury associated with monopoly aftermarket prices is substantially mitigated by equipment competition.

D. THE PRICE DISCRIMINATION THEORY

The observation that a firm with market power selling several complementary products can earn greater profits if it controls all of those products (components of the system) rather than just one is well known and applies not only to aftermarkets, but also if all the components are sold at once. Control of all the components permits greater price discrimination. However, this theory applies only to a firm with market power in the equipment market, since a firm with no equipment power has no substantial ability to price discriminate.[24]

My concern here is again whether there is substantial, predictable consumer injury that can be avoided by application of the antitrust

[24] To be more precise, traditional thinking in industrial organization economics is that a firm in a competitive market cannot engage in price discrimination. It does appear, however, that even firms with limited market power (i.e., firms that face less than perfectly elastic demand for their product but fall far short of being monopolists) can and do engage in price discrimination. The degree of price discrimination in markets with competitive structures remains a puzzle for economists. *See, e.g.,* Severin Borenstein & Nancy Rose, *Competition and Price Dispersion in the U.S. Airline Industry,* 102 J. POL. ECON. 653 (1994).

laws to aftermarket practices. Suppose that a manufacturer indeed can discriminate more effectively by controlling the servicing of its equipment as well as the supply of replacement parts. What is the impact on customers?

The manufacturer's control over the service aftermarket does not give the manufacturer "more" market power. After all, the ISOs still must, by assumption, purchase their parts (or some other key input) from the manufacturer. That input, and the original equipment itself, is the basic source of market power, and the firm's market power ultimately depends upon the attractiveness of substitute systems, i.e., on the ability of independent entities to assemble an entire system (equipment, parts, and service) to compete with the manufacturer in question.

Instead of augmenting the manufacturer's market power, control over the service aftermarket arguably widens the scope for price discrimination. The impact of excluding aftermarket rivals thus involves a comparison of two regimes of price discrimination: (1) the perfectly legal regime in which parts are used as a metering device to discriminate among different types of customers (along with other discrimination devices, such as quantity discounts); and (2) the possibly illegal regime in which additional methods of price discrimination are possible by virtue of the exclusion of independent service organizations (e.g., discrimination based on response time, charging more for customers who can least tolerate downtime and thus will pay extra to have their equipment fixed very quickly).

Economic theory provides no general guidance as to whether price discrimination increases or decreases overall efficiency, consumer surplus, or total output. Generally, a manufacturer's ability to engage in additional forms of price discrimination can enhance or detract from overall efficiency. Furthermore, added price discrimination can benefit or harm consumers in the aggregate. Certainly it tends to benefit some customers and harm others, although identification of the winners and losers from particular forms of price discrimination is both tricky and fact-intensive. If parts and service are used in the same fixed proportions by all buyers, controlling service provides the manufacturer with no additional ability to price discriminate, and thus has no impact on consumers.

The main point here is simple: the impact on consumers of preventing certain forms of price discrimination is unclear (consumers can win or lose), and unlikely to be highly beneficial. We are not talking here about a comparison between monopoly prices and competitive prices. We are talking about a comparison between one scheme of price discrimination

by a firm with equipment market power and another scheme of price discrimination. An antitrust policy designed to impose one scheme of price discrimination instead of another is very unlikely to be a major source of consumer benefits.

From a practical, litigation standpoint, the Price Discrimination Theory appears to provide plaintiffs with a method of elevating a firm that lacks monopoly power in the equipment market, but may still have some ability to engage in price discrimination (e.g., a firm with 40 percent of the equipment market) into a firm with monopoly power in its proprietary aftermarket. Given the ambiguous implications of price discrimination for efficiency and for consumer surplus, it is far from clear that this additional legal route will ultimately benefit consumers.

E. End-User Class Actions Involving Aftermarkets

The original *Kodak* case was brought by Kodak's aftermarket competitors, i.e., independent service organizations. Following the Supreme Court's ruling in *Kodak*, customers, i.e., end-users of equipment, have also brought claims in the form of class actions, alleging that they were injured by manufacturers' exclusionary aftermarket policies. The end-user damage claims in these class actions can dwarf the lost-profits damage claims in ISO lawsuits, as evidenced by the end-user class action brought against Xerox[25] and Xerox's settlement of that class action, as well as a more recent end-user class action against Kodak itself.[26] Class actions involving aftermarket claims have the prospect of being brought in a wide range of industries.[27]

Consider the problem faced by the lawyers seeking to launch an antitrust class action against a firm in a competitive equipment market. What end-user class is consistent with the available theories?

(1) The Surprise Theory only involves damages to customers who owned equipment at the time of a policy change, not to those purchasing in full awareness of the defendant's aftermarket policies. Logically, therefore, any class of end users would be confined to one cohort of customers, which itself can run into problems with the four-year statute of limitations. Damages are further confined to those customers who left themselves open to installed-base opportunism, not even all customers in the cohort. For example, a customer who leased equipment rather than

[25] R&D Business Systems v. Xerox Corp., No. 2-92-CV-042 (E.D. Tex. Feb. 23, 1993).

[26] Kopies, Inc. v. Eastman Kodak Co., No. C94-0524-BAC (N.D. Cal. Jan. 1994).

[27] *See, e.g.*, Telecom Tech. Servs., Inc. v. Rolm Co., Civil Action No. 9-94-CV-145 (E.D. Tex. 1994) (a class action against a manufacturer of telecommunications equipment (PBX systems)).

bought it received the benefits of systems competition; it is hard to see how such a customer should be in the end-user class.

(2) The Costly Information Theory applies only if customers are unable to evaluate equipment on a life-cycle basis, which is difficult to argue if the equipment is expensive and the buyers are businesses. Should the class consist of only those buyers who were unable to intelligently purchase equipment based on the total cost of ownership? In any event, as I noted above, damages are markedly reduced once one accounts for the discounting of equipment in anticipation of aftermarket markups.

(3) The Limited Manufacturer Commitment Theory requires that contractual remedies were highly imperfect, which can be difficult to sustain when many customers sign long-term contracts, or obtain extended warranties, when they purchase their equipment. Like the Costly Information Theory, it suffers from the fact that end-user damages are greatly attenuated by equipment competition, as indicated by the "Injury Ratio" calculations given above.

The Kodak class action is instructive as regards the dangers now facing firms in competitive equipment markets as they fashion their aftermarket policies.[28] In the Kodak class action, plaintiffs' lawyers relied on the Price Discrimination Theory, perhaps because of the limitations associated with the other theories just noted.[29] This required them to argue that Kodak had market power in the equipment market, despite Kodak's modest share of the high-volume copier market, and despite the fact that plaintiffs in the original *Image Technical Services v. Eastman Kodak Company* case had conceded that Kodak lacked equipment market power.

Furthermore, the very essence of the Price Discrimination Theory is that the manufacturer can engage in additional price discrimination by excluding ISOs from the service aftermarket. Therefore, the impact on consumers is highly uneven. Depending upon whether a particular consumer was favored or disfavored under the two regimes, that end user may gain or lose from the additional discrimination. This hardly sounds like suitable material for a class action, in which all members of

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[28] Professor Janusz Ordover of New York University and I served as experts for Kodak in the class certification process.

[29] In particular, plaintiffs did not rely on the Surprise Theory. Their challenge to Kodak's refusal to sell parts to ISOs appeared to have nothing to do with the fact that Kodak allegedly altered its parts policies in 1985, a point the Supreme Court emphasized, but merely on the refusal to deal itself. This suggests that even manufacturers that have in place long-standing policies may be vulnerable if they have high market shares in their own proprietary aftermarkets.

the class are allegedly injured by the challenged practice.[30] Nonetheless, a class consisting of all of Kodak's high-volume copier customers was recently certified based on this theory. It would appear that many manufacturers in competitive equipment markets are vulnerable to class actions of this type.[31]

III. REMEDIES IN REFUSAL TO DEAL CASES

Another problem with *Kodak*-style cases is the fashioning of a remedy. If the manufacturer must make parts available to ISOs, or must license its diagnostic software to them, what are reasonable rates to sell parts and license the software? To an economist, a refusal to deal is equivalent to an infinite price: the manufacturer simply will not sell its parts to ISOs. If such sales are required, the manufacturer will typically have an incentive to set a price that includes the opportunity cost of lost service revenues. Indeed, with this pricing the manufacturer welcomes entry by efficient ISOs.[32]

Do the courts intend to oversee the prices charged by manufacturers to ISOs for replacement parts? This seems unlikely, given the understandable historical aversion of the courts to regulating the prices set by businesses. Nor would a rule requiring manufacturers to sell parts to ISOs on the same terms as these parts are sold to end users prevent the manufacturer from charging the profit-maximizing price for parts, which properly includes the opportunity cost of lost service margins when equipment is serviced by third parties, including self-service customers.

IV. CONCLUSIONS

What is the state of economic thinking regarding *Kodak* and aftermarkets? For firms in competitive equipment markets, two theories of antitrust liability—the Costly Information Theory and the Limited Manufacturer Commitment Theory—appear to apply only in relatively limited circumstances. And even where these theories apply, they imply sharply limited consumer injury, as shown by my "Injury Ratio" calculations and the model provided in the Appendix.

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[30] See Herbert Hovenkamp, *Tying Arrangements and Class Actions*, 36 VAND. L. REV. 213 (1983), for further discussion along these lines.

[31] It is too soon to see if these class actions will prevail on the merits. Based on the *Xerox* and *Kodak* cases, however, it does appear that plaintiffs have a good chance of getting these classes certified and perhaps winning a settlement.

[32] This relates to one of the business justification arguments for a refusal to deal: the manufacturer can always extract profits in the form of parts prices, and a refusal to deal suggests another motive, such as protecting the manufacturer's brand name from being damaged by poor ISO service, e.g., through false attribution.

Another theory—the Surprise Theory—has limited applicability and is explicitly short-run in nature. In any event, a manufacturer who chooses to engage in installed-base opportunism can do so without adopting policies to exclude aftermarket rivals, simply by raising the price of the aftermarket input controlled by the manufacturer, be it replacement parts, diagnostic software, or something else.

All this leaves us with a real question of whether consumers stand to gain much, even if firms generally make their parts available to ISOs.[33] After all, manufacturers can and will include in their parts prices an opportunity-cost component reflecting lost service revenues when ISOs buy parts and capture service business away from the manufacturer using those parts. In addition, imposing a duty to deal may limit the value of legitimate intellectual property (Xerox had patents on many of its proprietary parts, for example, and many firms have copyrighted diagnostic software that they may feel they must license to independent service organizations) and thus stifle innovation. Further problems can arise if competitive firms are not permitted to flexibly alter their aftermarket policies for fear of antitrust liability, just as problems arise if firms in competitive markets cannot modify their distribution methods for fear of antitrust exposure.

A fourth theory of liability—the Price Discrimination Theory—applies to manufacturers with some ability to engage in price discrimination, although they may well not have monopoly power. On its own terms, this theory generally implies that some buyers benefit from the exclusionary practices and others are harmed, so any net consumer harm may be small, and indeed price discrimination may well promote efficiency and raise consumer welfare. The Price Discrimination Theory, combined with the *Kodak* decision, seems to be primarily a method by which a firm with some ability to engage in price discrimination, e.g., a firm with 40 percent of the equipment market, becomes subject to antitrust scrutiny because it is deemed to have monopoly power (e.g., a 90 percent share or more) in its proprietary aftermarkets. I am not convinced that this extension of the reach of the antitrust laws is wise.

Many commentators criticized the *Kodak* decision precisely because it appeared to open the door to questionable antitrust actions, even though the Court was theoretically correct about the possibility of genuine aftermarket power. One has to wonder how deeply the Court thought about the trade-offs in summary judgement standards: Is the risk greater

[33] I do not discuss here the legitimate business reasons for manufacturers restricting the sale of parts to ISOs. To the extent that firms are forced to sell parts by the antitrust laws, despite these legitimate concerns, consumers will be positively harmed by antitrust policy.

from inviting lawsuits that have little merit, or in prohibiting those few lawsuits in which aftermarket power is of genuine concern? To date, the critics' fears seem to have been borne out, despite the fact that plaintiffs have yet to win any final judgements in "parts cases" based on market power in proprietary aftermarkets.

There is genuine irony in all of this. Above all else, the *Kodak* decision stands for the notion that economic theories alone are not sufficient to determine antitrust cases; the courts must explore the facts. Is it not odd, therefore, that plaintiffs are now able to invoke the Court's theories from *Kodak* about costly information and consumer switching costs to bring antitrust actions, including massive class actions, and to obtain sizable settlements, even if the facts in these cases do not nearly conform to the pattern that the Court said might possibly arise and raise genuine antitrust concerns?

APPENDIX

IMPACT ON CONSUMERS OF EQUIPMENT COMPETITION AND AFTERMARKET MONOPOLY

1. *Objective and Overview*

This appendix provides the formal model and calculations underlying my statements in the text regarding consumer injury with a competitive equipment market and monopolized brand-specific aftermarkets. To reiterate, the main point of this modeling effort is to show that consumer injury associated with supracompetitive aftermarket prices tends to be far less than the consumer injury usually associated with monopoly power. The reason is that, with competitive equipment markets, any supracompetitive aftermarket profits are effectively rebated to consumers in the form of discounts on equipment. With foremarket competition and aftermarket monopoly, the seller does not earn profits for the overall system. Therefore, consumer injury is confined to the inefficiency ("deadweight loss") created because equipment prices and aftermarket prices depart from costs. The primary inefficiency arises because the supracompetitive aftermarket prices, combined with the equipment discounts, induce consumers to replace equipment more frequently than would be efficient.[1]

To measure this inefficiency requires a model with the following features: (1) consumers choose when to replace their equipment, and they shorten the replacement cycle when aftermarket prices are at supracompetitive levels; (2) sellers compete in the equipment market, discounting equipment in anticipation of receiving supracompetitive aftermarket prices. Using this model, one can calculate the injury suffered by consumers when aftermarkets are monopolized, but equipment markets are competitive. As shown below, this injury tends to be far less than the consumer injury that would arise if aftermarket prices were set at the same supracompetitive levels without equipment competition causing the monopoly profits to be "rebated" to consumers.

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[1] This idea is nicely developed in Severin Borenstein, Jeffrey MacKie-Mason & Janet Netz, *Antitrust Policy in Aftermarkets*, *supra* this issue, 63 ANTITRUST L.J. 455 (1995).

2. *How Buyers Choose When to Replace Equipment*

Consider then the following model of foremarket and aftermarket competition. Each piece of equipment costs K to manufacture, and each unit of "service" costs c for the manufacturer to provide. I am not distinguishing here between the various components of service (such as replacement parts and service technician labor). Instead, I simply model a composite "maintenance and repair" function, which I call "service," which may be supplied competitively or may be monopolized by the manufacturer, as described below.

The older a piece of equipment is, the more maintenance and repair it requires. I assume that a machine's service requirements grow linearly over time, so that a machine that is t years old requires $\alpha + \beta t$ units of service per unit time.[2] These growing maintenance requirements provide an incentive for the owner of a machine to replace the machine when it reaches a certain age.[3]

Each buyer by assumption requires one machine for the indefinite future. The buyer chooses when to replace an aging machine with a new one in order to minimize the total life-cycle costs associated with having a machine. I denote by T the length of the replacement cycle, as optimally chosen by the customer.

The price for a new piece of equipment I denote by E, and the price of a unit of service I denote by p. How these prices are determined will be discussed below. For now, the buyer merely takes these prices as given, be they set by competition or by a monopolist, and chooses a replacement cycle to minimize costs.

The optimal replacement cycle depends on the following factors: (1) the extent to which older machines require additional service, as captured in the parameter β; (2) the time value of money for the buyer, denoted by the interest rate r; (3) the price the buyer pays for a new piece of equipment, E; and (4) the price the buyer pays for service, p.

If the buyer keeps a machine for a length of time T, the total cost over that period of time is given by

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[2] To put this in more concrete terms, the key assumption is that each year a machine ages means that it requires β more units of service in the following year. If $\alpha = 5$ and $\beta = 2$, a new machine would require 5 units of service during its first year of operation, a three-year-old machine would require 11 units of service during the next year of operation, and a six-year-old machine would require 17 units of service over the coming year.

[3] In fact, the machine is replaced in this model when its market value falls to zero. Of course, in the real world buyers differ in their needs, so when one user replaces an old piece of equipment, that machine typically finds its way to another customer, very likely one more willing to tolerate downtime or frequent repairs in exchange for reduced expenses.

$$C = E + p\int_0^T (\alpha + \beta t)e^{-rt}\,dt\,.$$

Performing this integration gives

$$C = E + \frac{\alpha p}{r}(1 - e^{-rT}) + \frac{\beta p}{r^2}(1 - e^{-rT}) - \frac{\beta p}{r}Te^{-rT}\,.$$

Choosing a replacement cycle of T requires that a new machine be purchased at date T, and again at date $2T$, $3T$, etc. Adding up the cost of all these machines, and the service for them, properly discounted, leads to a total cost associated with replacement cycle T of

$$M = \frac{C}{1 - e^{-rT}},$$

which can be written as

$$M = \frac{E}{1 - e^{-rT}} + \frac{\alpha p}{r} + \frac{\beta p}{r^2} - \frac{\beta p}{r}\frac{Te^{-rT}}{1 - e^{-rT}}. \tag{1}$$

This is the total cost that the buyer seeks to minimize through suitable choice of the replacement cycle, T.

An expression can be obtained describing the optimal replacement cycle, by differentiating the total cost, M, with respect to the length of the replacement cycle, T, and setting the result equal to zero. Skipping over several steps of algebra in this process, we obtain the following expression for the buyer's optimal replacement cycle T^*:

$$\frac{r^2}{\beta}\frac{E}{p} = e^{-rT^*} + rT^* - 1\,. \tag{2}$$

Notice that the optimal replacement cycle is determined by the parameters r and β, and the variables E and p, as noted above. Since the expression on the right-hand side of equation (2) is increasing in T^*, it follows that T^* is larger if E is higher or if p is lower. Indeed, the replacement cycle is driven by the relative price of equipment and service, E/p. The more expensive is service relative to equipment, the shorter is the replacement cycle.

3. *Measuring Consumer Injury from Service Overcharges*

We are now ready to measure the consumer injury associated with service overcharges, i.e., associated with service being priced above competitive levels. In this model, the competitive price of service is $p = c$, so $p > c$ represents a supracompetitive service price.

In order to measure the cost to consumers of "traditional" monopoly overcharges for service, we must determine the extra cost the buyer must pay if service prices, p, rise.

The analysis is simplified if I can pause here and temporarily take a more abstract approach. We know that the total cost incurred by the buyer to keep one machine working properly indefinitely is given by M, which in turn depends upon E, p, and T, as shown in equation (1). This relationship can be written as $M = M(E,p,T)$.

The extra cost imposed on the consumer if p rises is given by

$$\left.\frac{dM}{dp}\right|_{MONO} = \frac{\partial M}{\partial p} + \frac{\partial M}{\partial T}\frac{dT}{dp},$$

recognizing that the buyer can and will adjust (decrease) T if p rises, i.e., $dT/dp < 0$. However, since T is chosen optimally by the buyer, $\frac{\partial M}{\partial T} = 0$, so (i.e., by the envelope theorem) we have

$$\left.\frac{dM}{dp}\right|_{MONO} = \frac{\partial M}{\partial p} = \frac{\alpha}{r} + \frac{\beta}{r^2} - \frac{\beta}{r}\frac{Te^{-rT}}{1 - e^{-rT}}. \tag{3}$$

Equation (3) applies if the price of service rises and there is no change in the price of equipment. This is the injury associated with traditional monopoly overcharges for service.

The point of this Appendix is that consumer injury from service overcharges is seriously attenuated in the presence of equipment competition, even if aftermarkets are securely monopolized. To show this, I compare the consumer injury measure just calculated with another measure of injury that applies when increases in the price of service, p, trigger decreases in the price of equipment, E, such as occur in the presence of equipment competition.

Accounting for adjustments in equipment prices, we get a different expression for consumer injury, namely

$$\left.\frac{dM}{dp}\right|_{COMP} = \frac{\partial M}{\partial p} + \frac{\partial M}{\partial E}\frac{dE}{dp} + \frac{\partial M}{\partial T}\frac{dT}{dp}.$$

Again the final term is zero since T is chosen optimally by the buyer, so the injury expression becomes

$$\left.\frac{dM}{dp}\right|_{COMP} = \frac{\partial M}{\partial p} + \frac{\partial M}{\partial E}\frac{dE}{dp}. \tag{4}$$

Equation (4) applies if the price of equipment adjusts due to equipment competition when the price of service rises. This is the injury associated

with aftermarket monopoly in the presence of foremarket competition. Since $\frac{\partial M}{\partial E} > 0$, i.e., the consumer is harmed if equipment prices rise, and since $\frac{dE}{dp} < 0$, i.e., equipment prices in fact *fall* when service prices rise, we know that consumer injury from service overcharges is attenuated by equipment competition. I will now quantify that concept.

Specifically, I seek to calculate an injury ratio, which I define to be the ratio of consumer injury with equipment competition to consumer injury without equipment competition. If this ratio is 0.2, it tells us that equipment competition reduces consumer injury to 20% of what it would otherwise be. In terms of my model, the injury ratio is given by

$$J = \left.\frac{dM}{dp}\right|_{COMP} / \left.\frac{dM}{dp}\right|_{MONO},$$

which becomes

$$J = \left(\frac{\partial M}{\partial p} + \frac{\partial M}{\partial E}\frac{dE}{dp}\right) \Big/ \frac{\partial M}{\partial p}. \tag{5}$$

To calculate this ratio, I need one further step of analysis in order to determine how much equipment prices fall when service prices rise, i.e., to calculate dE/dp.

4. *Equipment Pricing with Aftermarket Monopolies*

Equipment competition drives the profits of sellers to zero (competitive levels), by assumption. The profits earned by the seller from a single piece of equipment are given by:

$$(E - K) + \int_0^T (p - c)(\alpha + \beta t)e^{-rt}\,dt.$$

Integrating this expression and setting it equal to zero gives

$$E = K - \alpha(p - c)\frac{(1 - e^{-rT})}{r} - \beta(p - c)\left(\frac{(1 - e^{-rT})}{r^2} - \frac{Te^{-rT}}{r}\right). \tag{6}$$

The analysis is a bit tricky at this point, since the relationship between E and p depends upon T, and T itself adjusts when p rises. I must account for the fact that E and T are jointly determined by p. Equation (6) shows how competition determines E, given p and T. I also need to rely on equation (2) above, which shows how T is determined given E and p. Rewriting (2) here we have

$$\frac{r^2}{\beta}\frac{E}{p} = (e^{-rT} + rT - 1). \tag{7}$$

Equations (6) and (7) together determine E and T jointly as functions of p.

The procedure now is to (slightly) increase p, and to use equations (6) and (7) together to see how E adjusts in order to calculate dE/dp. This requires a number of steps of algebra, leading to the following expression:

$$\frac{r^2}{\beta}\frac{dE}{dp} = (e^{-rT} + rT - 1) - \frac{r(1 - e^{-rT})^2(\alpha + \beta T)}{\beta(1 - e^{-rT}) + mr(\alpha + \beta T)e^{-rT}}, \tag{8}$$

where $m = (p - c)/p$ is the percentage markup over cost for aftermarket service.

5. *The Injury Ratio*

Finally, I am ready to report the injury ratio discussed in the text of the article. To this end, it is useful to note that, using (2), the traditional monopoly injury, which is the denominator in the injury ratio J, can be written as

$$\left.\frac{\partial M}{\partial p}\right|_{MONO} = \frac{\alpha + \beta T}{r} - \frac{E}{p(1 - e^{-rT})}.$$

This expression is obtained by differentiating M with respect to p and then using (2) to substitute at a suitable point.

Armed with equation (8), the expression in (5) for the injury ratio J can be calculated, albeit with quite a few steps of algebra, which I will not repeat here. The result is:

$$J = \frac{mr(\alpha + \beta T)^2(1 - e^{-rT})e^{-rT}}{[(1 - e^{-rT}) + mr(\alpha + \beta T)e^{-rT}]\,[(\alpha + \beta T)(1 - e^{-rT}) - rE/p]}. \tag{9}$$

The most important thing to note about this admittedly forbidding formula is the m in the numerator. If $m = 0$, then $J = 0$. In other words, if the markup on aftermarket services is small, the injury to consumers associated with increases in aftermarket prices is likewise very small.

In other words, if we start in a situation where aftermarket service prices are competitive, $p = c$, and we are asked how much injury consumers would suffer from a slight increase in p, the analysis here shows that the injury ratio is zero in this case. In other words, if aftermarket prices are close to competitive levels, small increases in aftermarket prices lead

to virtually no consumer injury, because of the compensating reduction in equipment prices generated by equipment competition.[4]

This is a telling observation. For example, Borenstein, MacKie-Mason, and Netz argue that aftermarket prices will be somewhat above competitive levels because manufacturers' incentives to keep aftermarket prices down are imperfect, since the reputation mechanism is imperfect.[5] To the extent that manufacturers have valuable reputations to protect (and those who can most credibly do so will have a competitive advantage), aftermarket prices will be only slightly above cost, and consumer injury will be slight indeed.

More generally, the injury ratio tends to be well below unity, telling us that aftermarket power tempered by foremarket competition is unlikely to be a very useful place to look if one takes the objective of the antitrust laws to be the protection of consumers.

Let me give some numerical examples using equation (9) to prove this point. I have adopted as my "base case" a situation where the interest rate is 10%, a new machine requires two units of service ($\alpha = 2$), and with each year of age a machine requires one more unit of service ($\beta = 1$), and in which equipment is about fifteen times as expensive as each unit of service, making it optimal for consumers to replace their equipment every six years ($T = 6$). Under these circumstances, if aftermarket services are priced 10% above cost, $p = 1.1c$, then the injury ratio is about 14%, i.e., the consumer injury from service overcharges is about one-seventh as much as the traditional monopoly injury, or six-sevenths of the potential injury is eliminated by virtue of equipment competition.

By way of comparison, if service is priced only 5% above cost, the injury ratio falls to about 7.5%, and if service is priced 20% above cost, the injury ratio is still only 24%.

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[4] Economists will recognize this result as a special case of the general finding that small distortions starting from competition levels cause only second-order deadweight losses, combined with the fact that the consumer injury here is precisely the deadweight loss, since all aftermarket "profits" are returned to customers in the form of equipment discounts.

[5] *See* Borenstein, MacKie-Mason & Netz, *supra* note 1. For a general discussion of why reputations cannot perfectly substitute for explicit contractual protections, see Carl Shapiro, *Consumer Information, Product Quality, and Seller Reputation*, 13 BELL J. ECON. 20 (1982).