# The Inkjet Aftermarket: An Economic Analysis

Robert E. Hall

August 8, 1997

Abstract:

Replacement ink is available in aftermarkets defined by the products compatible with particular inkjet printers. Aftermarket theory establishes that consumers can be harmed by high prices in these aftermarkets, even if there is some degree of competition in the printer market. Survey evidence shows that consumers have little knowledge of replacement ink prices when they purchase printers. As a result, they become locked in to particular aftermarkets. Only competition in those aftermarkets can discipline price—competition in the printer market is not effective to restrain aftermarket ink prices. Consequently, printer makers have unambiguous incentives to exclude rivals from the replacement ink aftermarkets. Methods for exclusion include the assertion of questionable design patents and the modification of products without corresponding consumer benefits. At present, printer makers enjoy high market shares in their own aftermarkets and they do not compete in each others' aftermarkets.

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This study was prepared on behalf of Nu-kote International, Inc. Robert E. Hall is Professor of Economics at Stanford University and Senior Fellow at Stanford's Hoover Institution.

## I. Introduction

This paper evaluates competition in the aftermarket for replacement ink for inkjet printers and measures the potential effects of exclusionary acts that limit competition and raise prices in those aftermarkets. As the personal computer has become a ubiquitous household appliance—now present in about 35 percent of American homes—the inkjet printer has become the standard method for making colored printed output. The advent of color inkjets has been an important factor, since no other technology is capable of delivering color printing at a cost anywhere near as low as the inkjet. Replacement ink has become a significant product in the U.S. economy, with retail sales projected at roughly $3 billion in 1997.[1]

Replacement ink constitutes an aftermarket, because consumers first make primary purchases of printers. Because printers sell at retail for $200 to $500, purchasers are locked in to an important extent. The owner of a particular brand and model of printer is limited to using replacement ink products compatible with that printer. Total U.S. sales of inkjet printers in 1996 were about $4.6 billion,[2] compared to replacement ink sales of about $3 billion, so the typical user spends somewhat more for the printer than for replacement ink.

The leading seller of inkjet printers is Hewlett-Packard. Canon and Epson are also important sellers. Canon sells printers under the Apple brand name. Lexmark, a spin-off from IBM, is also present in the market. An inkjet printer

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[1] See Section IV for further discussion of the size of the market and competition in the market.

[2] *Business Week*, July 7, 1997, estimates worldwide inkjet printer sales to be $6 billion. *Computer Reseller News* estimates that the U.S. is 61 percent of world sales, implying that U.S. sales are

uses specially formulated liquid ink contained in reservoirs. Typically the black reservoir holds up to 40 ml. of ink, good for about 600 to 800 pages of black-and-white printing. Colored ink is contained in three smaller reservoirs. The ink flows from the reservoir to the printhead, where it is sprayed onto the paper to form characters or graphics. Some manufacturers combine the printhead and the reservoir, so that the user replaces the printhead and the ink at the same time (all of HP's inkjets work this way). Others sell ink tanks separately from the printhead. For simplicity, in the rest of this paper, I will use the term *cartridge* to mean the manufacturer's recommended printhead-tank assembly or separate replacement ink tank. Each printer or family of printers takes a unique cartridge. For example, a number of HP's monochrome DeskJet printers, faxes, and combination fax-printers (OfficeJets) use the 26A cartridge. Only replacement cartridges that are electronically and physically strictly compatible with the manufacturer's cartridge will operate in the printer.

All inkjet printer makers sell replacement cartridges. Computer stores such as CompUSA have racks arranged by manufacturer offering these cartridges. The retail list price of, for example, the black-ink HP 26A cartridge is $31.95, and it sells for prices between about $21 and $32.[3] Color cartridges are more expensive. Ink tanks not containing printhead are cheaper.

There are doubtlessly huge variations across consumers in their intensity of use of inkjet printers. At $25 per cartridge and 800 pages per cartridge, ink

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about $3.6 billion. If the typical ratio of retail to wholesale price is 1.25, then total U.S. sales at retail are about $4.6 billion.

[3] On May 3, 1997, Staples office supply in West Haven, Connecticut, priced the 26A at $22.29 for one and $21.84 for 5 or more.

costs 2.5 cents per page.[4] If the consumer prints an average of 6 pages per day over 3 years, for a total of 6,500 pages and 7 cartridges, total replacement ink cost (for 6 cartridges) is $150, about half the cost of the printer. For a less intensive user, replacement ink cost would be less.

Although no data have been made public by the printer makers, it appears that replacement cartridges are hugely profitable. For example, *Forbes* magazine quotes John Jones, an analyst at Salomon Brothers, as stating that the margin on cartridges for inkjet printers like HP's DeskJet is 60 percent.[5]

Independent sellers of replacement ink sell products of two basic types:

1. *Replacement cartridges*. When the cartridge contains only ink and not the electronic printhead, it is usually straightforward for an aftermarket seller to produce a compatible tank and ink supply. Because the printheads contain technology protected by patents that have not so far been challenged, sellers of replacement cartridges for HP printers and others containing integrated printheads purchase printheads from the printer manufacturer and adapt them to accept replaceable ink tanks. The independent replacement ink product is a kit containing one printhead cartridge from the printer manufacturer and several replacement tanks.

2. *Refilling.* The second replacement ink product provides a method for refilling the original cartridge, produced by the printer manufacturer, with new ink from an independent producer. The consumer may purchase a kit that permits refilling at home, or may mail in a spent cartridge for refilling at the independent seller's factory.

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[4] This is based on HP's 26A cartridge, which is rated at 800 pages (black and white) per cartridge assuming an average coverage of 5 percent. This cartridge is used in HP's entry level printer, the DeskJet 400.This cartridge sells for $24.95 at CompUSA.

[5] *Forbes,* January 22, 1996, p.47. See also *Business Week,* July 7, 1997, for a similar estimate.

Disputes have developed between the printer manufacturers and the independent sellers of replacement ink products. The analysis of the issues in these disputes is the subject of this paper. The disputes involve attempts by the printer makers to limit the role of the independent sellers in the aftermarket for replacement ink. The printer makers have claimed patent and trademark protection that has been disputed by the independent sellers. In addition, the independents have challenged product modifications on the basis that their main effect was to disable competitors in the aftermarket rather than improve the products.

It is not the purpose of this paper to consider the details of the obstacles to competition in the replacement ink aftermarket. Each barrier to entry involves specific factual issues. Each one is defended by the printer makers on the grounds that the barrier is created by valid intellectual property rights, that the barriers are important to stimulate innovation, and that manufacturers should have broad rights to redesign their products without challenge from rivals. Actual and would-be competitors in the replacement ink market challenge the barriers as misuse of intellectual property rights and intended primarily to disable rivals in that market. I will comment broadly on how I believe patent law should be interpreted to achieve the highest social welfare in the aftermarket setting, and how I believe policy should deal with redesign issues in that setting.

My analysis has the following elements: In section II, I review and synthesize the theory of aftermarkets, with attention to those issues that arise in the replacement ink market. An issue of particular importance identified in that theory is the extent that consumers are informed about the aftermarket when they make their primary purchase decision. In Section III, I discuss evidence on this point, including a survey that I designed and conducted. Section IV considers the current state of competition in the replacement ink market. Patent rights and the tradeoff between incentives for genuine innovation and the role of patents as

barriers to entry are the subject of Section V. The role of product modifications—which may be innovations or ways to hobble replacement ink rivals—is the subject of Section VI. Section VII presents a rough quantification of the change in consumer welfare that would result from increased competition in the replacement ink aftermarket. Section VIII states the conclusions of the study within the traditional antitrust legal framework. Finally, Section IX reviews the European Commission's findings on the inkjet printer aftermarket.

## II. Aftermarket Theory

The Supreme Court's decision in *Kodak v. Image Technical Services*[6] has stimulated analysis of aftermarket issues by a number of economists. Carl Shapiro [1995] is the author of a widely-cited study. He identifies three elements that distinguish an aftermarket: (1) complementary components (here, printers and cartridges), (2) purchase of components at different times (printer first, replacement cartridges later), and (3) consumer lock-in (cost of printer). The definitions and applicability of the first two elements in the market for replacement ink for inkjet printers seem obvious and I will not dwell on them. Lock-in requires some further comment.

### A. Lock-in

Lock-in occurs when consumers cannot recover the cost of their investment in the primary product if they discover that aftermarket products are more expensive than they expected. Absent lock-in, consumers may be able to shift to another primary product to escape the effects of an attempt by one seller

[6] 112 S. Ct. 2072 (1992).

to elevate the price of the aftermarket product. Interestingly, lock-in disqualifies the standard example of an aftermarket product, razor blades. Since razor handles—the primary product—are inexpensive and given away free by razor system manufacturers, there is no consumer lock-in, so razor blades are not an aftermarket in the sense that Shapiro (and I) conceive of aftermarkets.

Shapiro's discussion of lock-in contains an important but subtle conceptual error. In footnote 14, p. 490, he writes:

> The mere fact that a customer has purchased a piece of capital equipment does *not* [emphasis in original] 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.

Shapiro here considers the sunk cost from the perspective of the individual. Absent market-wide changes, he is correct that the sunk portion of an investment in equipment (such as a printer) is the transaction cost or bid-ask spread—the difference between the purchase price and the selling price. But in the analysis of aftermarket issues, what matters is the effect of a market-wide change. Elevation of aftermarket prices will lower used equipment prices. This effect needs to be included in the concept of the sunk cost—it is the difference between the purchase price before high aftermarket prices become known to the market in general and the sale price after they become known.

In addition, it is important to understand—as I believe Shapiro does—that the relevance of the sunk-cost measure of lock-in depends on the existence of

alternatives in the primary market. Consumers cannot escape the effect of high prices in the aftermarket for products compatible with one brand of equipment if the same situation exists in the aftermarkets for all brands.

Even by Shapiro's narrow concept of lock-in, I believe it is fair to say that inkjet printer purchasers are locked in to the aftermarkets for replacement ink products compatible with the printers they own. The purchase price of a printer, as I indicated in the previous section, is around double the lifetime ink purchases of a fairly intensive user. The selling price of a used inkjet is unlikely to be even half its purchase price, even without considering the depression in the used price if replacement ink products became more expensive.[7] Hence the option of selling the printer to escape elevated replacement ink prices does little to control price of replacement ink. Lock-in is substantial—a printer manufacturer who monopolizes the aftermarket for replacement ink compatible with its installed base of printers could extract substantial value by elevating the price before the owners junked the printers. Fortunately, other factors keep cartridge somewhat under control, as discussed in the next section.

## B. Types of Potentially Harmful Conduct in Aftermarkets

Shapiro discerns four categories of harm that consumers might suffer as a result of limitations of competition in an aftermarket. I will consider them in turn and comment on their applicability to the inkjet printer aftermarket.

### 1. Installed Base Opportunism

In general, opportunism is the failure to perform in accord with expectations created earlier. In an aftermarket, opportunism would take the form of setting higher prices in the aftermarket than consumers expected when they

made their primary product purchases. Opportunism could also take the form of other policy changes, such as excluding low-priced rivals from the aftermarket. As Shapiro observes, there are two basic methods that have evolved in modern economies to control opportunism, contracts, and reputation.

Before discussing the role of contracts and reputation in deterring opportunism, I should note that the issue of deterrence is not central in determining social policy with respect to opportunism, any more than the fact that most families teach their children not to steal makes it unnecessary to enforce laws against theft. If, despite contracts and reputation, there are actual occurrences of opportunism, the resulting harm to consumers should be considered in determining policy.

The contractual solution to potential opportunism in the case of inkjet printers could provide protection against opportunistic price increases. For example, a printer could be sold with a dozen chits, each giving the owner the right to buy a cartridge at a specified price. There is no need to pursue this idea, because nothing like it has ever happened in the printer or similar markets. Further, it is hard to see how the contractual solution can protect against opportunism directed by the printer maker at its rivals in the aftermarket. How could Canon write a contract with its printer purchasers that guaranteed them the continuation of the right to buy cheap ink tanks from independent sellers?

Reputation appears to be the stronger force helping to control opportunism. One reason that printer makers do not typically jack up aftermarket prices for older printers that have large installed bases may be their fear that buyers of new printers would then expect the same fate. It is my understanding that the prices of cartridges set by printer makers in their own aftermarkets are

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[7] There are advertisements for used printers on the Web. For example, an HP820cse, "in excellent

generally steady over time, and I believe that reputation is probably the primary explanation for the forbearance of printer makers from exploiting their installed bases, especially in the most tempting situation of discontinued printer models.

The reputation mechanism rests on well-informed consumers. To the extent that buyers of inkjet printers have not heard much, one way or the other, about the cartridge market, the reputation mechanism may not give much protection, especially against more subtle forms of opportunism. Consider the following example: A printer maker modifies the cartridge for a group of printers with a large installed base. The modified cartridge is compatible with those printers, but is incompatible with the refill kits sold by an independent supplier of refill ink. The printer maker enjoys an opportunistic increase in sales and profit, without raising its price. Its reputational loss is limited to those customers who understand just what happened. Its rival in the replacement ink market suffers a reputational loss as well, because its customers find that its refill kits will not work as promised.

Economic analysis of reputation is challenging. A standard framework for modeling reputation is a repeated game, but it is well known that almost any type of behavior can be the equilibrium of a repeated game, from the rankest opportunism to the most forbearing. Shapiro does not attempt a formal analysis of reputation, and it is unlikely that one would be fruitful.

It is worth noting that most of Shapiro's discussion of reputation is off the point for inkjet printers. He observes that opportunism cannot extract more value from the installed base than the cost of switching to another seller (a seller who credibly commits not to be opportunistic itself). In the case of inkjet printers, as I discussed earlier, those switching costs create a large amount of consumer value

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condition, includes software," is offered for $125. New, the printer sells for $400 at CompUSA.

that is at risk for opportunism. Fortunately, no inkjet printer maker has made anything like a frontal attack on the hundreds of millions of dollars of value at stake.

Shapiro observes that opportunism is least likely in a growing market and most likely in a sunset market. The inkjet printer market has a succession of aftermarkets, some for sunset products—printers no longer made or close to discontinuation—and new products with new cartridges. Because the same manufacturers sell in both the sunset markets and the new markets, there is some protection in the sunset markets. Nonetheless, the incentives for the more subtle forms of opportunism are strong.

Finally, Shapiro considers the remedy sometimes recommended in certain aftermarket situations. If the independent seller is dependent on the primary equipment maker for some input—spare parts in the example Shapiro considers—the remedy is sometimes proposed that the primary equipment maker be compelled to sell the input to the independent aftermarket seller. This remedy will have little substantive value. As Shapiro points out, the primary equipment maker can gain a benefit similar to that available from opportunism by charging high prices for spare parts. To make the remedy meaningful, the terms of the sale of spare parts have to be part of the remedy.

Some of the modes of supply of replacement ink for inkjet printers do not involve any dependence on the printer makers—there is no analog to spare parts. Refill kits, refill services, and compatible ink tanks can be provided without any physical input controlled by the printer makers (there may be control through design or utility patents). Remedies that permit the continuation of these products in the aftermarket would not be undermined by the high pricing of some essential input by the printer makers.

## 2. Imperfectly Informed Consumers

Shapiro observes that consumers can be victimized in aftermarkets if they make their initial purchase without knowing their requirements for aftermarket products and the prices of those products. They could choose a type of equipment and become prisoners in the aftermarket for complementary products, where they would be locked in. To put the point in reverse, sellers facing customers who make primary purchase decisions giving full weight to terms in aftermarkets will have fewer opportunities to exploit locked in customers. Notice that this argument rests on the success of some mechanism to prevent subsequent opportunistic behavior, such as contracts or reputation. Shapiro's analysis correctly describes some markets for sophisticated equipment, where purchasers are experts who do full analyses of life-cycle costs and are able to contract for their aftermarket purchases at the time of their equipment purchases.

In other markets, where there is less at stake and purchasers are less likely to be completely informed and to take advantage of methods to prevent opportunism, Shapiro identifies a number of factors that may limit the vulnerability of consumers to victimization in aftermarkets.

First, uninformed buyers gain from the presence of informed buyers. A seller of primary equipment will hesitate to set high prices for aftermarket products or to exclude rivals from aftermarkets because the seller will lose equipment business from customers who are aware of conditions in the aftermarket. However, the optimal strategy for the primary seller is to split the difference—to set aftermarket prices somewhere between the high level that would maximize profit if all buyers were uninformed and the lower level that would maximize profit if all buyers were informed about the aftermarket. In other words, the proposition can be stated in reverse: Informed buyers suffer from higher aftermarket prices to the extent that the market contains some uninformed buyers as well. (This analysis presumes that sellers cannot discriminate and set

different terms for the two types of buyers—a presumption that I believe is accurate for inkjet printers and replacement ink.)

Second, there are markets for information about primary markets and aftermarkets. In the case of inkjet printers, computer magazines provide information that would be useful to printer purchasers if they chose to make use of it. A little information is available at the point of sale for printers as well. I will review evidence about how well informed inkjet printer users are about the replacement ink market in the next section. In general, the protection that consumers receive from being well informed is a factual issue, specific to individual types of equipment.

Third, repeat buyers are bound to be better informed than are first-time buyers. For products where most purchasers are newcomers, this factor is of less importance.

Shapiro gives a full analysis of market equilibrium with imperfectly informed customers. He accepts that sellers of primary equipment will exploit the market power that they enjoy in their aftermarkets and that aftermarket products will be correspondingly overpriced in comparison to the case of perfectly informed customers. He notes that the pursuit of aftermarket products will alter incentives in the primary equipment market. The benefit that a seller enjoys from selling one more piece of equipment—the marginal revenue—derives not just from the sale of the equipment but also from the sale of high-priced aftermarket products for that equipment. The prices of inkjet printers are lower than they would be if replacement ink were sold at lower prices.

The argument that high aftermarket prices result in low primary market prices applies to both competitive and concentrated primary markets. In the competitive case, firms will enter the primary market until they have depressed the price of equipment enough below cost to offset the profit that each will earn from exploiting its market power in its aftermarket (assuming that each equipment

seller is able to restrict entry to its aftermarket). In the case of an imperfectly competitive primary market, sellers will equate the marginal revenue of printers (counting derived aftermarket profit as revenue) to marginal cost. Equality will occur at a higher level of output and lower equipment price than the same calculation done without regard to aftermarket profit.

Shapiro observes that the consumer benefit from lower equipment prices is necessarily lower than the consumer loss from higher aftermarket prices. The appendix to his paper verifies this proposition in a rather full and complicated model, but the point is essentially universally correct. The only situation where the consumer does not lose is where equipment and aftermarket products are perfect complements used in fixed proportions. In the realistic case where printer owners adjust their use of cartridges in response to the price of cartridges, as Shapiro demonstrates, the loss from overpricing of ink is not made up fully by the gain from underpricing of printers. In the case of a competitive primary market (the case Shapiro analyzes), there are two triangles of deadweight burden associated with the two price discrepancies—both can be eliminated by bringing competition to the aftermarket.

Shapiro does not consider the case of an imperfectly competitive primary market, but there too the consumer benefits from increasing competition in the aftermarket (see Borenstein, MacKie-Mason, and Netz [1996], discussed below). The supporting analysis appears in Section VII, where the effects of changes in the competitive structure of the replacement ink market are quantified.

### C. Shapiro's Other Theories

Shapiro discusses two other theories of limited relevance to the inkjet printer market. One is presented by Borenstein, Mackie-Mason, and Netz [1995]. In their model, primary equipment sellers set the same aftermarket for both the installed base and for future customers who have not yet made their initial

equipment purchases. Because the demand of the former group is less elastic than of the latter, the profit-maximizing aftermarket price is higher than it would be if the seller could set a price that applied specifically to the current generation of new equipment buyers. Shapiro calls this the theory of limited manufacturer commitment. It has limited relevance here because of the evidence that new inkjet printer buyers are poorly informed about the aftermarket, contrary to the assumption made by Borenstein *et al.*

Shapiro's last theory is based on discrimination by equipment sellers among groups of customers. It too has limited relevance for inkjet printers, where opportunities for discrimination seem to be few.

### D. Conclusions on Aftermarket Theory

With respect to the inkjet printer market and replacement ink aftermarket, a principal implication of the accepted theory of aftermarkets is that there is a social welfare loss when purchasers are less than fully informed about the aftermarket when they make their primary purchase and when primary equipment sellers can restrict entry to their aftermarkets. The loss is in comparison to a primary market with the same structure—competitive, oligopolistic, or monopoly—but with more competition in the aftermarket. The exploitation of market power in the aftermarket is partially, but not fully, offset by lower prices in the primary market. Notice that *the welfare loss exists whether the primary market is competitive, imperfectly competitive, or a monopoly*.

The second important implication is that *opportunism in aftermarkets is socially harmful*. Though there are forces that limit opportunism—contracts and reputation—they are not foolproof. Whether or not opportunism has occurred and consumers harmed is a factual question.

## E. Other Studies of Aftermarket Economics

Shapiro [1982] develops a model of seller reputation consistent with the previous discussion. He shows that reputation provides less than full incentives to sellers. The model of reputation is non-strategic—reputation is a stock built up by the firm as consumers learn about its product.

Borenstein, MacKie-Mason, and Netz [1996] provide a detailed analysis of models of aftermarkets with well-informed customers who form expectations about future aftermarket pricing from current actual pricing. Primary equipment sellers sometimes deviate opportunistically from those expectations. The authors show that, in general, there is a net social gain from removing barriers to entry in aftermarkets. The gain is present for competitive primary markets, duopolies, and monopolies.

The same authors [1995] develop a non-technical discussion of results covered above.

Shapiro and Teece [1994] observe that market power in aftermarkets is compatible with competition in the corresponding primary market. They consider the possibility of opportunism and how reputation and contracts might limit opportunism. They also consider the importance of customer information about the aftermarket at the time that primary purchase decisions are made.

Klein's [1993] commentary on *Kodak* observes—in agreement with all later economic analyses—that there is no principle of economics that eliminates market power from aftermarkets when the primary market is competitive. His main focus is on the idea that Kodak's challenged conduct—withdrawal of support for independent servicers of copiers—is opportunistic but does not have an antitrust character. To the extent that the determination of what type of price-elevating conduct falls within the ambit of antitrust law, the question is outside the scope of this paper. Klein asserts, without much supporting analysis, that reputation and contracts are adequate to prevent almost all opportunistic

aftermarket price increases. (p. 50). He compares Kodak's opportunism to that of a landlord who jacks up the price of parking to take advantage of tenants who are locked in to renting in a building. This, too, he would characterize as outside of antitrust considerations: "...it does not make the landlord a monopolist or the dispute an antitrust case." (p. 59). Klein creates an apparatus for studying aftermarket issues that basically labels all price elevations resulting from lock-in as "holdup" rather an as an exercise of market power. Consistent with this view, he argues for a nonstandard definition of the relevant market, where individual products in the market could be weak substitutes but not in separate markets.

## III. Consumer Information about Replacement Ink

Consumers obtain information about inkjet printers from a number of sources, including magazines, catalogs, and point of sale literature. They may also obtain information by word of mouth, from friends and salespeople. I will discuss information available in the first three sources, and then describes the results of a survey of printer owners asking about their knowledge from all sources.

### A. Information Available to Consumers about Replacement Ink Cost

Computer magazines provide some information about the cost of consumables for inkjet printers. For example, the November 6, 1996, issue of *PC Magazine* contains a summary table for 7 new models of inkjet printers that gives the (list) prices of black and color cartridges and costs per page for 5 percent black coverage and 15 percent color coverage. No information is provided about street prices of cartridges or about alternatives to the printer manufacturer as suppliers of replacement ink. One paragraph of the article discusses ink cost. A fair summary of the article is that some information about ink prices is available to the reader who seeks it out, but there is no advocacy of ink price comparisons

for the reader who has not thought about the subject. By comparison, the article is full of detailed comparisons of the initial costs of the printers—actual street prices—speeds, and print quality.

Catalogs are generally silent on replacement ink costs. A recent Egghead Computer catalog pushes the Canon BJC-240L for $179.92 and the BJC-4200 for $229.96. Selling points include: speed, resolution, memory, warranty, size, color quality, and software. Computer Discount Warehouse carries the HP DeskJet 694C ($299), the Canon BJC-240 ($179), the BJC-240 ($199), the BJC-4200 ($249), the Epson Stylus Color 400 ($229), 600 ($299), and 800 ($449), and the Lexmark Color Jetprinter 2030 ($199) and 2050 ($247). In no case is there any mention of ink requirements. There is no mention of replacement ink prices for any model except the Lexmark 2030, where replacement cartridges are offered, but no indication of the number of pages the user can expect to get from a cartridge.

HP and Canon provide point of sale information printed on a postcard-sized slip of paper. In HP's case, the front of the slip describes selling points, such as speed, size, resolution, and paper handling. The most prominent point for the DeskJet 400 is "HP's Lowest Priced Color Printer." The reverse of the slip gives technical information and ink price information—number of pages per cartridge and cost per page, both for black only. There is no information about ink cost for color printing. For the DeskJet 820Cse and 870Cse, the information includes ink cost for color as well as for black.

Canon's point of sale slips provide similar selling points and technical information, but no information is provided about ink consumption or cost.

Epson's point of sale slips contain information in pages per cartridge on the reverse side, but no information is provided about cost per cartridge or per page.

## B. Consumers' Actual Knowledge of Replacement Ink Cost

To measure consumers' knowledge of replacement ink costs, I designed and conducted a survey of owners of inkjet printers. To avoid problems associated with differences across brands, the survey was restricted to owners of the single largest brand by far, Hewlett-Packard. Respondents belonged to the panel of households operated by National Family Opinion, a respected survey research organization. The survey instrument was designed in collaboration with Dr. Susan Russell, at SRI International. Dr. Russell holds a Ph.D. from Stanford University and has many years of experience in survey research. She and I have collaborated in a number of earlier successful surveys on consumer choice. The interviews were carried out by trained interviewers at NFO who were unaware of the purpose or sponsor of the survey.

Interviews were carried out with the adult who was most involved in deciding to buy the HP inkjet printer (ownership of the printer was already recorded in NFO's information about panel members). Model name and number were ascertained. Of the 100 respondents, 74 had already purchased a refill cartridge. After obtaining this preliminary information, the interviewer then stated, "For my next questions, I'd like you to think back to what you knew about the printer when you bought it, not what you've learned about it since then." Of course, it is likely that the respondents were unable to forget their subsequent information, especially in the case of the 74 who had purchased replacement cartridges.

The next question asked "When you bought this printer, did you think that HP cartridges were the only ones that would fit in it, or did you think that you could use some other brands of cartridges as well?" 62 of the 83 respondents who replied yes or no (as opposed to don't know) thought that only HP cartridges would fit. In that respect, consumers are reasonably well informed that HP (unlike other printer makers) is able to exclude rivals from the replacement cartridge

business. However, one firm sells a replacement ink product that packages an HP-made cartridge with non-HP ink tanks that snap into the HP cartridge. It is possible that some of the 21 respondents who thought other cartridges were compatible were thinking of this product, not focusing on the fact that it uses a genuine HP cartridge.

The next question was "When you bought this printer, did you think that the cartridges could be refilled, or did you think that you had to replace the entire cartridge?" 24 respondents were aware of the possibility of refilling and 74 mistakenly believed that replacement was required.

Next, the interviewer asked those who were aware of the refill possibility, "Did you think that you could refill your HP cartridges with ink supplied by another company, or did you think that only HP ink would be acceptable?" 13 knew that alternative ink was available and 7 thought that only HP ink could be used (in fact, HP does not supply refill ink to consumers, nor does it refill cartridges itself).

All respondents were then asked, "When you bought the printer, did you think you knew about how much a replacement cartridge would cost?" 56 said they knew and 43 said they did not. Those who said they knew the cost were asked "And, at that time, about how much did you think you would pay for a replacement cartridge?" Of the 56 who believed they were knowledgeable about the price at the time of purchase, 54 actually provided a number. Some of these respondents could only purchase one type of cartridge for their printers; others could purchase either a black and white or a color cartridge for their printer. I looked at the ratio of the respondent's expected price to the price of the cartridge at CompUSA, a representative retailer of cartridges. For those who could purchase two types of cartridge, I took the cheaper so that the analysis would understate the percentage whose beliefs about the price were unrealistically low.

The following table reports the ratio of respondents' belief about the price to the actual price at CompUSA:

| *Ratio of belief to actual price at CompUSA* | *Number of respondents* | *Percent of respondents* |
|---|---|---|
| Less than 50 percent | 1 | 1.9 |
| 50 to 60 percent | 3 | 5.6 |
| 60 to 70 percent | 4 | 7.4 |
| 70 to 80 percent | 5 | 9.3 |
| 80 to 90 percent | 10 | 18.5 |
| 90 to 100 percent | 14 | 25.9 |
| 100 to 110 percent | 10 | 18.5 |
| 110 to 120 percent | 6 | 11.1 |
| More than 120 percent | 1 | 1.9 |

More than two-thirds—69 percent—of the respondents believed that the price was below the CompUSA price of the cartridge or the cheaper of the two cartridges compatible with the printer. Respondents systematically believed prices to be lower than they actually are.

The interview then turned to the second component of cost per page, the number of pages per cartridge. Respondents were asked, "Still thinking back to the time when you bought this printer, did you think you knew about how many pages you could print before you had to replace the cartridge?" 16 answered that they knew and 84 said they did not. Of these 16, only 13 were able to provide a number when asked, "At that time, about how many pages did you think that would be?" Consumer information about this dimension is much lower than about cartridge prices, which is understandable because the cartridges are usually sold where printers are sold. However, the number of pages per cartridge is available only from some product reviews and point of sale slips (HP does not even give data on pages per cartridge in its product information website, which gives a wealth of other information about its cartridges). Those who believed they knew

were asked “At that time, about how many pages did you think that would be?” The answers were:

| *Number of pages per cartridge* | *Number of respondents* | *Percent of respondents* |
|---|---|---|
| Under 350 pages | 6 | 46.2 |
| Between 700 and 800 pages | 3 | 23.1 |
| Between 1000 and 2000 pages | 3 | 23.1 |
| 5000 pages | 1 | 7.7 |

Respondents could have been informed about ink cost per page without breaking it down into cartridge price and pages per cartridge. Accordingly, respondents were asked, “When you bought the printer, did you think you knew what the cost per page to print would be?” Only 3 respondents believed they did know; 97 believed they did not. Of the three who had beliefs, one replied don’t know to the question “And, at that time, what did you think the cost was for each page printed?” One believed it was one cent (too low) and the other 10 cents.

The three respondents who believed they knew the per page cost were asked “Finally, when you bought the printer, did you think you knew what the cost per page would be to print using other brands of inkjet printers.” None of the three replied that they did have this knowledge. Thus, not a single respondent believed they had the information needed to compare different brands by the criterion of ink cost.

## C. Conclusions about Consumer Information on the Cost of Replacement Ink

A review of the information available to consumers about the cost of replacement ink and survey evidence about their actual information suggests that

people buy inkjet printers without information about that cost. Although around half the purchasers have ideas about the prices of cartridges that are not unrealistic, few know about the number of pages per cartridge. Almost none have beliefs about the cost of ink per page and none at all, among the 100 respondents in the survey, have beliefs about the comparative cost of ink per page among brands of printer.

## IV. Current Actual Competition in the Replacement Ink Aftermarket

As noted at the beginning of this paper, replacement ink for inkjet printers is a product of considerable importance in the U.S. economy. Sales in the past year were approximately $3 billion.[8] Sales are expected to grow at double-digit rates in the coming years.

At present, printer makers account for the great proportion of sales in their own replacement ink aftermarkets. For example, Nu-kote estimates that its sales of ink compatible with HP's leading cartridge, the 26A, account for roughly 4 percent of total sales of ink in the 26A aftermarket, and that other independent replacement ink sellers account for somewhat less. HP's sales in that aftermarket are in the range of 93 percent of the total market. I believe that other aftermarkets are similar, both for HP and for other printer makers.

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[8] This estimate should be considered quite rough. It was derived in the following way: *Business Week*, July 7, 1997, estimates that 5 percent of HP's revenue is derived from inkjet cartridge sales. Revenue is about $40 billion, so cartridge revenue is about $2 billion worldwide, or $1.2 billion in the U.S. HP accounts for about half the inkjet market, so the market total at wholesale is about $2.4 billion. Taking the ratio of retail to wholesale price to be about 1.25, retail sales are roughly $3 billion.

The current state of the replacement ink market reflects the balancing of a number of forces. First, the printer makers have adopted a number of exclusionary tactics that have been challenged by independent replacement ink sellers. Absent those tactics, the shares of independent sellers would be larger and the price of replacement ink lower. Second, the potential role of independent sellers has disciplined the price of replacement ink sold by the printer makers. If legal and effective methods for excluding independent ink sellers were put in place, this potential competition would cease to hold prices down and replacement ink would become even more expensive.

Although, as I understand it, the major printer manufacturers are cross licensed under each others' patents, none competes in another's ink aftermarket.

As I understand the current state of the replacement ink market, there are no methods of exclusion of widely accepted legality that limit the role of replacement ink sellers. In particular, there are no patents of unchallenged validity that prevent independent sellers from providing replacement ink to inkjet printer owners. Although patents held by HP and others on printheads have not been challenged, it is possible to supply replacement ink to be used in conjunction with a printhead made by the printer maker. Existing cartridges can be refilled or fitted with replaceable tanks. Consequently, the resolution of current controversies, such as the validity and use of design patents and the legitimacy of product redesigns, will determine the extent of competition in the replacement ink market in the future.

## V. The Role of Design Patent Rights

Some printer makers have obtained design patents for their cartridge designs. This type of patent protects the artistic appearance rather than the

function of the cartridge. Because the cartridge is concealed within the printer, there is a limited scope for cartridge design to be an important element of the appearance and appeal of the printer itself.

As with patents in general, design patents have a potential for misuse. The intended purpose of patent rights is to provide an incentive for the creation of intellectual property.[9] The basic right conferred by a design patent is to prevent another from using the design without the owner's permission. Thus the owner may assert a patent against another manufacturer, claiming the right to exclude that manufacturer's product from the market or to collect a royalty set by the court. Misuse occurs when a patent is asserted inappropriately, because the patent is invalid or because it is asserted against a party who is not actually practicing the patent.

The misuse of design patents to exclude sellers from markets in general and aftermarkets in particular is socially harmful. When the assertion of patent rights excludes other sellers from a market, the patent owner becomes a monopolist in the market, resulting in higher prices and a loss of social welfare. In the case of a patent that is, first, valid, and, second, would actually need to be practiced in order to compete in the market, social policy tolerates the loss of social welfare because it is offset by the incentive that monopoly profits provide for innovation. Where misuse occurs—either because the patent is invalid or because those excluded from the market would not be making use of the patent—there is no offset. As a result, it is important to determine that a patent is valid before permitting its enforcement and important to allow the exclusion only of those sellers who actually use the patent.

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[9] For a general discussion of the economics of patents and other intellectual property, with many references, see Besen and Raskind (1991).

My analysis of the theory of aftermarkets in Section II shows the conditions under which a seller in a primary equipment market such as the inkjet printer market would have an incentive to misuse a design patent to exclude rivals in an aftermarket such as the replacement ink market. First, the exclusion could provide the seller with the extra profit available from installed-base opportunism. That is, the seller could attract customers to its equipment by permitting the development of a competitive aftermarket, and then monopolize the aftermarket by asserting design patents against its rivals in the aftermarket.

Second, and more importantly for the replacement ink market, the lack of information possessed by consumers when they buy their inkjet printers (documented in Section III) makes it attractive for the printer manufacturers to capture large profits in the replacement ink aftermarket. The success of this strategy depends on the exclusion of rivals in the replacement ink market. Assertion of design patents is one of the tools available to printer makers to lessen competition in the replacement ink aftermarkets and to add to their profit. As I noted in Section II, the incentive to exclude rivals in aftermarkets exists for any degree of competition in the printer market.

Because printer makers have unambiguous incentives to assert design patents in order to exclude rivals from their aftermarkets, it is important to examine carefully whether the design patents are valid and whether the excluded cartridges actually embody the protected designs.

## VI. Product Modifications

The modification of cartridges and printers is another way that printer sellers can exclude rivals from the replacement ink aftermarket. Even if modifications do not exclude rivals permanently, a practice of continual

modification can raise the costs of rivals, resulting in fewer rivals and higher replacement ink prices. When the printer maker modifies a printer to take a new cartridge design (typically in the context of introducing a new printer model), aftermarket ink sellers must redesign their products to be compatible with the new design. Printer makers have incentives to introduce new designs with better performance and lower cost. In that case, the redesign costs incurred by aftermarket suppliers are part of the cost of progress and the redesign will be socially beneficial. Unfortunately, printer makers also have an incentive to make arbitrary changes that render existing cartridges incompatible, because the printer maker inevitably has a head start in the cartridge aftermarket. During the transition, before independent ink suppliers can provide cartridges compatible with the new design, the printer maker can monopolize the aftermarket for cartridges compatible with the new design.

In addition, some aftermarket replacement ink products can be disabled by the printer maker even without any change in the design of the printer. Recall that some cartridges—including all those compatible with the printers made by the leading manufacturer, HP—include proprietary print heads. Independent replacement ink suppliers cannot make compatible cartridges because of strong patent protection. Instead, these suppliers provide kits so that end users can refill cartridges. Printer makers have an incentive to change the cartridge design so that the refill kits are no longer usable, even though the new cartridge is compatible with existing printers.

Thus, design changes—either to the printer-cartridge system or to the cartridge itself—are tools for excluding rivals from the replacement ink aftermarket. As Sections II and III showed, inkjet printer makers have strong incentives to exclude rivals from their aftermarkets. These incentives exist for any degree of competition in the printer market.

Economists have developed criteria for determining when a product modification serves the interests of the consumer and when it impedes competition and raises prices.[10]

First, in markets where technical compatibility determines the success of a rival, a seller may modify a product solely to disable a rival. Analysis of this form of predation is straightforward, because the modification has no offsetting benefit—its only payoff is to exclude rivals and increase market power. The great majority of economists would condemn this type of modification as anticompetitive, I believe.

Second, the more challenging issues arise when a product modification has a mixed character. The modification may improve a product on the one hand and exclude rivals on the other hand. One example is the *compensatory price test* developed by Ordover and Willig, which considers the possibility that the seller who introduces a product modification incompatible with a rival's product might keep the old product on the market after introducing the modified product. It is anticompetitive, according to the Ordover-Willig test, to take the old product off the market if there are customers who would pay enough to make it worthwhile to continue to sell it. The removal of the older product from the market is anticompetitive, in that case, because the removal is motivated by a desire to exclude the rival whose product is compatible with the older version but not the new version. In effect, the Ordover-Willig test asks whether a printer maker's decision to *remove* the earlier version of a cartridge from the market is a decision that added to profit, apart from its effect of excluding rivals from the replacement ink market. This is a different issue from the profit consequences of *replacing* the old version of the cartridge with the new version.

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[10] For example, Janusz Ordover and Robert Willig (1981 and 1983).

Determination of the harm from exclusionary acts in aftermarkets needs to consider the barriers to re-entry. If an excluded rival can re-enter the market quickly and re-establish competition, there is less need for legal intervention. However, the analysis needs to look further into the future than a single possibility of re-entry. If the printer maker can inflict costs on its aftermarket by asserting invalid design patents, by product modifications not beneficial to consumers, or by other means, the issue does not end with the possibility of re-entry after a single episode. Instead, the analysis should consider whether the threat to repeat these exclusionary acts as often as necessary may be enough to keep rivals permanently out of the aftermarket.

## VII. The Magnitude of the Benefits that Consumers Would Receive from a More Competitive Aftermarket

This section presents illustrative calculations of the magnitudes of changes in consumer surplus associated with changes in the structure of the replacement ink aftermarket. The calculations include both the effects in the ink market and the resulting effects in the printer market, along the lines suggested by Shapiro [1995]. This model was developed in association with Victoria Lazear, who has extensive experience in developing similar models of markets.[11]

The printer market is modeled as a three-player Cournot oligopoly with a competitive fringe. Each seller anticipates an extra benefit from selling printers equal to the profit margin on cartridges multiplied by the lifetime cartridge purchases from the printer seller. The standard Cournot model with constant elasticity of market demand is calibrated to the following illustrative assumptions:

[11] The model is available as an Excel spreadsheet from Applied Economics Partners.

| | |
|---|---|
| Leading seller's market share | 49 percent |
| Market share of competitive fringe | 6 percent |
| Profit margin of leading seller | 16.7 percent |
| Profit margin in cartridge market | 67 percent |
| Total cartridge purchases over lifetime of printer for marginal purchaser | 5 |
| Printer price | $300 |
| Printer sales, per year | 16 million |

The first step in the exercise is to calculate the implied market elasticity of demand for printers as the leading seller's share of the strategic part of the market (49 percent divided by 94 percent) divided by the effective profit margin on printers, counting both the printer sale and the downstream cartridge sales. To infer the leading seller's downstream cartridge profit per printer, I multiplied marginal cartridge purchases by the leading seller's share of the cartridge market.

The second step is to infer the profit margins and costs for the other two strategic players. The profit margin is the share of the strategic part of the market divided by the market elasticity. The level of cost is calculated from the profit margin and the price.

The result of this calibration is a model that infers the market price that will result from changes in the determinants of market equilibrium. I use the model to calculate changes in the printer price and in the quantity of printers sold when the profit from downstream cartridge sales changes.

I also calibrate a Cournot model of the market for replacement ink for the leading printer seller. The model has two strategic players, the printer seller and one independent strategic seller of compatible replacement ink products, together

with a competitive fringe. The illustrative assumptions underlying these calculations are:

| | |
|---|---|
| Leading seller's market share | 92.6 percent |
| Market share of competitive fringe | 3.7 percent |
| Profit margin of leading seller | 67 percent |
| Cartridge price | $25 |
| Cartridge sales, per year | 124 million |

Again, I calculate the market elasticity as the leading seller's share of the strategic part of the market divided by the profit margin. I infer the second player's cost level from its market share, as before.

I make two uses of the model of the cartridge market. First is to calculate the monopoly price and quantity sold, if both the strategic seller and the competitive fringe sellers were no longer present in the market. Second is to calculate price and quantity under a scenario of freer entry, where there are 3 strategic sellers of equal size with a combined market share of 40 percent. My calculations are for the leading printer seller's aftermarket—I assume no change in the other aftermarkets.

Based on the results for the two scenarios in the cartridge market, I solve the printer model to determine the resulting printer prices and quantities sold when the aftermarket profit varies.

The following table shows the results of the calculations:

| *Scenario* | *Cartridge price* | *Cartridge quantity in leading seller's aftermarket (millions)* | *Printer price* | *Printer quantity, all brands (millions)* |
|---|---|---|---|---|
| Monopoly | 27.21 | 60 | 295 | 15.9 |
| Limited aftermarket competition | 25.00 | 61 | 300 | 15.5 |
| More extensive aftermarket competition | 14.18 | 77 | 318 | 14.1 |

Notice that the price differences in the printer market caused by variations in cartridge profitability are not very large. Although the leading seller does have an incentive to expand printer sales and lower the printer price when there are monopoly profits available in the aftermarket, the effect is not large.

The following table describes the changes in consumer surplus between the two scenarios with competition and the monopoly aftermarket:

| *Scenario* | *Increase in consumer surplus in cartridge market (Millions of dollars per year)* | *Decrease in consumer surplus in printer market (Millions of dollars per year)* |
|---|---|---|
| Limited aftermarket competition | 133 | 81 |
| More extensive aftermarket competition | 889 | 347 |

Consumer gains from increased competition in the aftermarket are extensive and are not seriously offset by losses in the printer market.

## VIII. Conclusions Stated within the Traditional Antitrust Legal Framework

This paper takes the economist's approach to antitrust policy—I consider policy decisions that would result in changes in competition in aftermarkets and measure the resulting changes in social welfare. The core of the analysis is a study of how markets would change in the face of a particular antitrust remedy.[12]

Courts make use of a familiar standardized apparatus for considering potential antitrust remedies. The analysis begins by identifying a particular act as potential antitrust misconduct. A critical step is the determination of a relevant market within which consumers are harmed by the act (for example, the market for replacement ink products for a particular brand and model of inkjet printers). Then the firm whose act is under challenge must be shown to have market power above a specified threshold in that market (for example, the firm's replacement ink product dominates the market and sells for far above cost). The act must have an antitrust character—it must be of the type that can raise price and harm consumers (for example, exclusion of a rival who would offer cheaper replacement ink and lower the price of the dominant seller's ink products). Finally, the act must be wrongful in some sense—at least it is not an act with obvious consumer benefits, such as an innovation. At all steps, courts are properly suspicious of claims of harm made by disappointed rivals, where the source of the disappointment is the superior performance of the defendant.

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[12] The recent trial of the FTC's case against the office superstore merger has added to our understanding of the relation between the economist's case and traditional legal analysis. Both Staples's and the FTC's economists presented direct studies showing the amount of price change that would occur in superstores as a result of the merger. Staples's expert Jerry Hausman argued that cost reductions from the merger would result in lower prices. The FTC's expert Orley Ashenfelter argued that reduced competion would result in higher prices. The judge found in the

This paper is not about one particular challenged act involving replacement ink, but is about the general principles that I believe should be used in evaluating policy for a variety of acts. To illustrate the principles, I will discuss a hypothetical example. Suppose that a major printer maker, PrintMax, tries to prevent a rival, InkFill, from selling a kit to refill cartridges compatible with its line of PrintMax 1000 printers. Specifically, PrintMax modifies its cartridge so that InkFill's kits no longer function correctly. The modification is the challenged act. The consumers affected by the challenged act are the current and future owners of the PrintMax 1000 printers. The sellers in the relevant market are those who already make refill products compatible with the PrintMax 1000 or who would and could do so quickly if the price of the cartridge were elevated modestly. In my opinion, the identification of sellers must consider the challenged act, in the following way: The purpose of relevant market analysis is to see if the market will cure the effects of the challenged act. If the act disables one seller, the consumer will not be harmed if there are numerous other sellers unaffected by the act. On the other hand, if the act would disable all rivals by its nature, or if it is reasonable to expect that the act would be repeated against all rivals if found legal in the current proceeding, other rivals cannot play the role of curing the adverse effects of the act. Thus, the relevant market contains PrintMax and only those replacement ink sellers whose products will remain compatible with the modified cartridge design.

With respect to the demonstration that PrintMax has substantial market power in the relevant market, the issue is primarily whether PrintMax can raise the price of its cartridges significantly if it succeeds in excluding refill products. There are two possible reasons why PrintMax might be seriously constrained.

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FTC's favor and the merger has been abandoned. (This author was an innocent bystander in the

First, there may be other sellers who have figured out how to sell replacement ink for the new cartridge. Then it is a factual issue whether these sellers provide an effective constraint in comparison to the sale of the excluded refill products. In addition, the analysis needs to consider whether PrintMax may be able to disable these other refillers by other acts, such as different modifications of its cartridges.

Second, the analysis needs to consider whether a small price elevation in the replacement ink market might cause PrintMax to lose so many sales of printers as to constrain the replacement ink price. Here the analysis would consider evidence of the type I have reviewed in Section III about how well informed new printer customers are about replacement ink pricing. Unless PrintMax customers are vastly better informed than are HP customers, there is little constraint from the printer market.

The exclusion of a rival—with the effect of raising the price in the relevant market—seems plainly to have an antitrust character. The final issue in the hypothetical dispute between PrintMax and InkFill is whether the challenged act—PrintMax's modification of its cartridge to prevent InkFill from selling compatible replacement ink—has the wrongful character needed to constitute an antitrust violation. Here the analysis needs to weigh the benefits of a permissive standard for exclusionary product modifications against the social cost of the elevated product prices that will result from exclusion of rivals from aftermarkets.

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case).

## IX. The European Commission's Findings on the Inkjet Printer Aftermarket

The European Commission—charged with enforcing the antitrust laws of the European Union—recently considered a complaint by Pelikan, now a subsidiary of Nu-kote International.[13] Pelikan sought a ruling to require HP to supply Pelikan with inkjet cartridges on the same terms that HP supplied other large purchasers. The Commission rejected the application for interim relief (which I understand to be similar to a preliminary injunction under United States law). The Commission's rejection is not a final determination of Pelikan's case, but has only a preliminary character. Nonetheless, I believe it is useful to review the Commission's logic because it is the only judicial consideration of aftermarket issues in the inkjet printer area.

The Commission "has come to the preliminary conclusion that Hewlett-Packard does not hold a dominant position in the relevant market, which is the market for Hewlett-Packard printheads for inkjet printers."[14] (p. 4) On the one hand, the Commission found that there is a distinct relevant market for HP-compatible cartridges. Thus the Commission rejected the argument that HP-compatible cartridges were part of a larger market where one inkjet printer system (printer and compatible cartridges) competes against other systems. On the other hand, the Commission found (preliminarily) that HP did not have enough market

[13] Letter from the Director-General, Directorate-General IV—Competition, pursuant to Article 6 of Commission Regulation 99/63, Case No. IV/35.741—Pelikan/Hewlett-Packard and Canon, Your Application for interim measures of 14 November 1995 against Hewlett-Packard.

[14] The Commission uses the confusing term "printhead" for HP's integrated printhead-ink tank cartridge. However, page 2 of the letter shows a clear understanding that HP is the only possible supplier of the printhead component, and that Pelikan supplies cartridges combining a Pelikan ink tank and an HP printhead. I will continue to use the term cartridge to avoid confusion.

power in its own aftermarket to satisfy EU law, which specifies a concept of dominance of the relevant market.

The Commission made this finding on the basis that HP's conduct in the aftermarket was "constrained by the repercussions which that conduct could have on the demand for Hewlett-Packard inkjet printers." (p. 5) The Commission stated two reasons for this finding. First, "prior to choosing an inkjet printer a new consumer will carefully examine the total costs which he will incur" and second that "the switching costs for a user of an inkjet printer are in no way prohibitive." In other words, according to the Commission, consumers are protected in two separate ways: They investigate replacement ink costs before they purchase, and choose not to purchase brands with overpriced replacement ink. Second, even if they make a mistake and buy a printer with overpriced ink, they can easily correct the mistake by buying a new printer from a seller with reasonable aftermarket prices.

Both of these conclusions are based on factual errors. As I showed in Section III, consumers are not well informed about replacement ink prices when they purchase their printers. The Commission relies, without providing sources, on "the regular publication of tests in computer magazines" (p. 6) to provide consumers the necessary information. As I showed in Section III, that information, though sometimes present in computer magazines, is not featured and users are not urged to consider the replacement ink price as an important factor in their choice. And, as the survey evidence shows conclusively, consumers do not absorb enough information from all sources combined to be at all informed on this dimension. Not a single respondent out of 100 believed that he or she knew comparative replacement ink costs.

The Commission's conclusion that consumers are not locked in to their inkjet printers is also factually incorrect. The Commission's only evidence on this point is their statement that the price of an HP inkjet printer is less than DM 350

(footnote 3, p. 6), or less than $250, at the low end of U.S. street prices at the time. Even so, $250 is a substantial amount of locked-in value. The Commission states that "the costs of the printheads to be used during the lifetime of a printer generally exceed the printer price." (p. 6). The data and calculations I presented in Section I suggest that this would be true only for a minority of inkjet purchasers. The Commission lacks any point of reference about how high locked-in value would have to be to reach the level that the attempt to capture the locked-in value by elevating the aftermarket price would become a matter of sufficient importance to merit a remedy. By the Commission's standards, the printer manufacturers could nearly double the price of cartridges before exhausting locked-in value and still be outside the reach of EU antitrust law.

## X. Conclusions

The aftermarket for replacement ink for inkjet printers is an important market in the U.S. economy, with sales in 1996 of approximately $3 billion. Although a number of independent sellers of replacement ink have attempted to establish beachheads in these aftermarkets, they have achieved limited success so far. Printer manufacturers have high shares of their own replacement ink aftermarkets. Independent sellers face the risk of exclusionary acts by the printer manufacturers, including the assertion of design patents and the redesign of ink cartridges to make independent replacement ink products incompatible. No printer manufacturer competes in a rival's replacement ink market. The opening of the replacement ink market to strong competition from independent sellers could deliver hundreds of millions of dollars of benefits to inkjet printer users.

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