

Privacy, Economics, and Price Discrimination on the Internet

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ABSTRACT

The rapid erosion of privacy poses numerous puzzles. Why is it occurring, and why do people care about it? This paper proposes an explanation for many of these puzzles in terms of the increasing importance of price discrimination. Privacy appears to be declining largely in order to facilitate differential pricing, which offers greater social and economic gains than auctions or shopping agents. The thesis of this paper is that what really motivates commercial organizations (even though they often do not realize it clearly themselves) is the growing incentive to price discriminate, coupled with the increasing ability to price discriminate. It is the same incentive that has led to the airline yield management system, with a complex and constantly changing array of prices. It is also the same incentive that led railroads to invent a variety of price and quality differentiation schemes in the 19th century. Privacy intrusions serve to provide the information that allows sellers to determine buyers' willingness to pay. They also allow monitoring of usage, to ensure that arbitrage is not used to bypass discriminatory pricing.

Economically, price discrimination is usually regarded as desirable, since it often increases the efficiency of the economy. That is why it is frequently promoted by governments, either through explicit mandates or through indirect means. On the other hand, price discrimination often arouses strong opposition from the public.

There is no easy resolution to the conflict between sellers' incentives to price discriminate and buyers' resistance to such measures. The continuing tension between these two factors will have important consequences for the nature of the economy. It will also determine which technologies will be adopted widely. Governments will likely play an increasing role in controlling pricing, although their roles will continue to be ambiguous. Sellers are likely to rely to an even greater

extent on techniques such as bundling that will allow them to extract more consumer surplus and also to conceal the extent of price discrimination. Micropayments and auctions are likely to play a smaller role than is often expected. In general, because of strong conflicting pressures, privacy is likely to prove an intractable problem that will be prominent on the the public agenda for the foreseeable future.

Categories and Subject Descriptors

J.4 [Computer Applications]: Social and behavioral sciences; H.4 [Information Systems Applications]: Miscellaneous

Keywords

privacy, price discrimination, Internet and railroads

1. INTRODUCTION

The Internet offers the possibility of unprecedented privacy. According to the famous 1993 Pat Steiner cartoon in *The New Yorker*, "On the Internet, nobody knows you're a dog." But in practice, there are many who not only know you are a dog, but are familiar with your age, breed, illnesses, and tastes in dogfood. The Internet offers not only the possibility of unprecedented privacy, but also of unprecedented loss of privacy, and so far privacy has been losing.

The steady erosion of privacy and prospects for the continuation of this trend have been well documented (cf. [15]). Many observers, such as Scott McNealy of Sun Microsystems, say that privacy is irretrievably lost, and we should "get over" our hangups about it. However, the public is unwilling to "get over it," and concerns about collection and dissemination of information about our lives rate highly in opinion polls. Laws and regulations to protect privacy enjoy broad support. There are also novel technologies that attract public attention that can protect and enhance privacy [20]. However, the technologies that are developed and deployed most intensively are those that reduce privacy.

One of the many privacy puzzles is that even though the public shows intense concerns about loss of privacy, it is not doing much to protect itself. Privacy-protecting technologies have not fared well in the marketplace, and very minor rewards are enough to persuade people to sign up for grocery store loyalty programs. So are people being irrationally

paranoid, or is there something else that the loss of privacy might bring, that they instinctively fear?

Another puzzle is that so many commercial organizations are actively working to erode privacy. Governments often decrease privacy in attempting to combat terrorism, or tax evasion, or to increase their political control. Criminals invade privacy to make money by using other people's credit cards. Employers monitor their employees to increase productivity. And ordinary citizens, armed with an array of increasingly powerful and versatile tools, such as cameras in cell phones, are beginning to collect massive amounts of information that, if combined and analyzed, could lead to dramatic decreases in privacy [6]. However, most of the data collection efforts so far have come from private enterprises, and are the ones that attract most of the concern and publicity. These efforts are often extremely intrusive, and are extremely widespread. Moreover, they persist in spite of intense public opposition, even though there have not been too many commercially successful exploitations of the information that is gathered. Are the enterprises that engage in these practices irrational?

Many privacy advocates are concerned about the dangers of government control, limitations on freedom of speech, and related political factors. However, most of the pervasive privacy erosion is coming from the private sector, which is interested primarily in its customers' money, not control of their behavior. The standard explanation is that better information allows merchants to target ads better, thereby saving expense for the merchants and the trouble of discarding unwanted material for the customers. However, that explanation does not seem to be sufficient. For one thing, the effectiveness of ads is limited, and in particular online ads' response rates have been dropping recently. Advertising spending has been a fairly stable fraction of the economy for many decades, and is not likely to change.

The thesis of this paper is that the powerful movement to reduce privacy that is coming from the private sector is motivated by the incentives to price discriminate, to charge different prices to various customers for the same goods or services. Erosion of privacy allows for learning more about customers' willingness to pay, and also to control arbitrage in which somebody who might face a high price from a seller buys instead from an intermediary who manages to get a low price. The key point is that price discrimination offers a much higher payoff to sellers than any targeted marketing campaign. Adjacent seats on an airplane flight can bring in revenues of \$200 or \$2,000, depending on conditions under which tickets were purchased. It is the potential of extending such practices to other areas that is likely to be the "Holy Grail" of e-commerce and the inspiration for the privacy erosion we see. For it is the privacy intrusion represented by airplane tickets being non-transferable contracts with named individuals that enables airlines to practice yield management in the extreme form it has reached. (The requirement that passengers show government-issued identification cards before boarding, another privacy-eroding measure, plays a key role in making this effective.) When the sellers have less information about buyers, and less control over resale, possibilities for differential pricing are more limited, but even so, they are increasingly being exploited. For example, Dell

Computer is doing this extensively [23]:

One day recently, the Dell Latitude L400 ultra-light laptop was listed at \$2,307 on the company's Web page catering to small businesses. On the Web page for sales to health-care companies, the same machine was listed at \$2,228, or 3% less. For state and local governments, it was priced at \$2,072.04, or 10% less than the price for small businesses.

The dynamic pricing practiced by Dell has many more components, and it is indeed making the economy more efficient. As is described in [23], Dell has record low overhead costs, is a consistent leader in price cutting, and can satisfy customer demands with record speed and flexibility. Yet price discrimination appears to be a substantial part of the Dell success story. It is easy to understand why. Dell operates in a commodity market, with low net margins. Obtaining an extra 10% from a particular buyer is likely to be much more important for the bottom line than better targeted advertising.

In general, discrimination has a very negative connotation in our society, and various forms of it, in particular those based on age, gender, race, and religion, are illegal. However, price discrimination is an ancient technique that is widespread in the economy, although it is often disguised to avoid negative public reactions. It is frequently supported by government as a matter of public policy, sometimes explicitly, more often implicitly. The underlying reason is that standard economic arguments show that "generally, discriminatory prices [are] required for an optimal allocation of resources in real life situations" (p. 1 of [30]). Moreover, price discrimination is likely to play an increasing role in the future, for two main reasons. One is that an increasing fraction of the costs of producing goods and services consists of fixed one-time charges, with low marginal costs. (As an example, a software program might cost hundreds of millions of dollars to develop, but can be distributed at practically zero cost over the Internet.) The other reason is that modern technology is making it possible to price discriminate. For example, Coca Cola was discovered in 2000 to be experimenting with soda vending machines that would raise prices when temperatures were high. It might have wanted to do this in the past, but the technology was not available. Similarly, booksellers were in general not able to tell much about their customers in the past, while Amazon.com can.

The thesis of this paper is that the incentives to price discriminate and the increasing ability to do so are among the key factors in the evolution of our economy. The arguments in favor of this thesis are supported by a variety of examples. Some are recent, such as the evolution of yield management techniques in the airline industry. Some are older, such as the evolution of 19th century railroad pricing.

19th century railways will be cited extensively in this paper. They have often been compared to the Internet, usually as examples of revolutionary technologies that led to booms and crashes. There are indeed striking similarities in these areas [27]. However, the most relevant comparison between

the Internet and railways is likely to be in the area of pricing, a comparison that apparently has not been made before. The railways, like much of modern economy, especially that related to the Internet, faced very high fixed costs and low marginal costs. This produced strong incentives to price discriminate. The information technology of the 19th century allowed railways less freedom to price discriminate than airlines have today, though. Still, they did manage to price discriminate on a grand scale. The way society reacted then to such discriminatory practices may allow us to predict how our society will react to the spread and intensification of price discrimination that the Internet facilitates.

The incentives to price discriminate are likely to overcome the trend towards the type of dynamic pricing that is normally associated with claims of the “New Economy.” The standard predictions there (cf. [4]) are of widespread use of auctions, shopping agents, and related techniques. Price-line.com, eBay, and the myriad of B2B and B2C exchanges were supposed to be the forerunners of the new future. They were expected to bring back the art of haggling, and by better matching of supply and demand, as well as by lower transaction costs, to produce a significantly more efficient economy. They are growing, but their progress has been disappointing to their early proponents. The drive for price discrimination offers a partial explanation. If transactions are conducted anonymously, it is hard to tell how much a buyer is willing to pay. One can try to set up auction mechanisms to do that, but it is hard. It is easier and more productive to just charge more to those able to pay more, if one can. Note that governments do not collect taxes by sending their software agents to negotiate with those of the taxpayers. Instead, tax agencies use their coercive power to find out how much people earn, and then extract a large share.

That privacy-reducing measures are induced by the drive to price discriminate does not imply that the people designing or implementing those measures think of their work this way. Enterprises generally try to optimize their state by making small incremental changes within the confines of their technological, economic, and legal environment. It is usually only when we step back that we can say it was the social and economic advantages of price discrimination that shaped the choices faced by the decision makers. 19th century railroad managers who set freight rates and late 20th century American college administrators who decided on tuition fees were not aiming to price discriminate. They did what seemed best for their institutions, it’s just that their decisions led to increasing price discrimination. The managers who today invest in privacy eroding data collection systems are likely also often not thinking consciously about price discrimination. Instead, they are acting on the hope that the information they gather can be used to increase their enterprises’ profits. Usually what they have in mind for early applications are relatively mild departures from traditional business practices [33]. As they gain experience, better tools are developed, and general business practices change, their methods will evolve. The logic of price discrimination is likely to lead them eventually to techniques that will be much more overtly discriminatory.

The “New Economy” visions of [4] represent fairly small

departures from the usual practices in the current “Old Economy.” Auctions and automated shopping bots are well known, and fit well the standard economic models. Their spread, predicted in [4], does not require any major revisions of the economic canon. On the other hand, spread and intensification of price discrimination are likely to lead to major changes in thinking about economics, law, and public policy. “First degree” price discrimination, in which the buyer is charged his maximal willingness to pay, has long been treated in the literature as an unattainable ideal. Erosion of privacy and improved IT systems will enable a close approximation to this ideal to be achieved. Further, the presence of price discrimination in a market traditionally has been seen as a sign of monopoly power on the part of sellers. More competition has been regarded almost universally as a cure. However, there have always been some contrary examples, in which intensification of competition led to an increase in differential charging. As such examples proliferate, major revisions in the doctrine governing actions of courts and regulators will be required.

The logic of price discrimination suggests a future drastically different from the anonymous shopping agents of [4]. Instead, it leads to an Orwellian economy in which a package of aspirin at a drugstore might cost the purchaser \$1 if he could prove he was indigent, but \$1,000 if he was Bill Gates or simply wanted to preserve his privacy. Such a future would justify the efforts that enterprises are putting into destroying privacy. It would also show that the public’s concerns about privacy are well-founded, since current and historical precedents strongly suggest such a future would be resented. In practice, we are not likely to see this future any time soon. However, we will be catching an increasing number of glimpses of it, as enterprises move to exploit the opportunities that differential pricing offers.

The notion of a market price is very powerful, and underlies much of the theoretical framework of economics. Prices that depend on the buyer would require a complete rethinking of that framework. All those nice intersecting supply and demand curves would have to be replaced by more complicated constructs.

While the incentives to price discriminate are likely to be among the most powerful forces shaping our economy, the extreme Orwellian forms outlined above are not likely to appear, at least not soon. There are strong countervailing factors which are likely to slow the spread of overt price discrimination and push it into concealed forms. One such factor is arbitrage, in which buyers who secure low prices sell to those who are faced with high prices. For effective price discrimination, that method has to be circumvented. Airline yield management is as effective as it is because a ticket is a contract for carriage of a specific person, and is not transferable. In other areas, accepted practices and often laws have to be changed. That, however, requires time.

Another, even more important factor slowing the spread of price discrimination comes from behavioral economics. People do not like being subjected to dynamic pricing. There is abundant evidence of this, as shown, for example, in reactions to airline yield management and the moves to extend such practices to other areas. Yet more evidence can be

found in the reactions to 19th century railroad pricing, reactions that dominated politics at the end of that century in the U.S.. Even in the days when racial, age, gender, and other types of discrimination were not just widely practiced, but respectable, price discrimination aroused strong opposition. Such reactions are still common.

The public's dislike of price discrimination will be combined with new tools for detecting price discrimination. These tools are products of the same technologies that enable sellers to practice differential pricing. (The recent Amazon.com experiments with variable pricing were noticed and publicized almost immediately.)

The result is likely to be that price discrimination will grow, but in a concealed form. Stress will be on tactics such as bundling and loyalty programs, which tend to disguise the actual price that is charged. This means that auction mechanisms and micropayments are likely to be used in very limited situations. On the other hand, there will be continued pressure to erode privacy in order to find out just what the willingness to pay is, as well as to control how products and services are used. Thus privacy will continue to erode.

Price discrimination is often just one of many factors that lead to deployment of new technologies or business models. Thus it is often hard to tell just how important differential pricing is in various situations. However, it is likely to be among the most important motives in the growth in Digital Rights Management (DRM) schemes, as well as in the spread of licensing as opposed to outright sales, and in tying arrangements, such as security techniques that enable a printer to work effectively only with cartridges from that printer's manufacturer [2]. Price discrimination is clearly the main (although usually hidden) issue in the discussions of the future of the Internet, including the prospects for retaining the "end-to-end" principle. The debates about open access and peering are really about the extent to which differential pricings should be allowed. (The issue there, as it had been on the telephone network, on railways, and even on canals before that, is whether the carrier should be entitled to charge twice as much for transmission of a hit movie as for an obscure one.)

Governments are often expected and pressured to act to preserve privacy. Of course, governments are among the main privacy violators, in pursuit of either tax revenues or criminals. Still, those incentives are well understood, and at least in democratic societies can be controlled by the public. Thus there is still widespread hope that governments can be persuaded to limit privacy intrusions by the private sector. However, government roles in this area have been and likely will continue to be ambiguous. The problem is that price discrimination often does provide real measurable gains for social and economic welfare. It is not just a measure for increasing profits of sellers, as is often suspected (e.g., [1]). Increased price discrimination is often associated with increased competition as well as increased economic activity, and works to decrease profits. That is what happened in the 19th century, and induced the railroads to welcome regulation. This profit-decreasing but welfare-increasing effect of price discrimination is likely to keep regulators and legislators from interfering too much with the privacy-eroding

measures that facilitate it.

This paper is just an extended abstract. Because of space and time limitations, only the basic outlines of the evidence and arguments for the main thesis are presented here. For more details, see [26, 27, 28]. Those papers also contain acknowledgements to the many people who have helped me with comments and references.

There are many recent papers related to the work that summarized in this paper. Here I mention just a few, with fuller references in [26, 27, 28]. In particular, the main thesis about the importance of price discrimination and its relation to privacy erosion was already mentioned in [24], although only briefly. Many of the general points about the desirability of price discrimination have been made, for example in [10, 18, 34, 39]. That privacy erosion is leading to differential pricing is also increasingly recognized, cf. [1]. That price discrimination can arise in a competitive environment is also becoming recognized in the literature [21]. The most novel element in this paper appears to be the connection with 19th century railroad pricing.

2. THE IMPORTANT ROLE AND PREVALENCE OF PRICE DISCRIMINATION

Price discrimination is one of the basic concepts in microeconomics. For comprehensive surveys of the literature, see [30, 38]. A shorter and easier to obtain treatment is available in [39]. Here I just present a simple example which explains why price discrimination is economically and socially desirable. Suppose that Charlie is a consultant, and two potential customers, Alice and Bob, are interested in getting him to write a report on implementing digital cash. Suppose also that Alice is willing to pay \$700 for such a report, while Bob is willing to pay \$1,000. Suppose also that Charlie's cost (which is likely to be the opportunity cost, for example the price that will persuade him to write the report as opposed to going to the beach) is \$1,500. If Charlie has to charge the same price to both Alice and Bob, the report will not get written. Any price up to \$700 per copy will persuade both Alice and Bob to buy, but will bring in at most \$1,400, which will not be enough to get Charlie to do the work. Any price between \$700 and \$1,000 will only attract Bob as a buyer, and again will not bring in the required \$1,500, and any price above \$1,000 will find no buyers at all. On the other hand, if Charlie can sell the report to Alice for \$650 and to Bob for \$950, then by conventional economic arguments everybody should be happy. Charlie will collect \$1,600, more than the \$1,500 that makes him indifferent between writing the report and surfing, and so should be satisfied. Alice and Bob will each get the report for \$50 less than they are willing to pay, and so both should also be happy. Thus a transaction with differential pricing will make everybody better off.

The example shown above does suffer from the usual limitations of toy economic models, but it does demonstrate the essential features of differential pricing, and how it can make everybody better off, at least in the standard economic model. In particular, Charlie has to have at least some idea of what Alice and Bob are willing to pay (so no anonymous shopping agents, please), and a way to keep Alice from reselling the report. Thus privacy and first-sale doctrine have

to be limited.

In practice, sellers have usually solved the problem of determining customers' willingness to pay and at the same time avoided the fairness issue through versioning. Almost identical products are sold at differing prices, although production costs are almost the same. A standard example is that of hardcover versus paperback editions of books. Such versioning will be treated in the next section. Here I just present some examples of essentially pure price discrimination.

Senior citizen and student discounts are a well known type of price discrimination. A much less obvious form is that of periodic sales in stores, which serve to discriminate between informed and patient buyers and the rest [37]. Price-matching offers (in which a store promises to match any competitor's price) play a similar role [8].

Another visible example of price discrimination is in scholarly journal publishing. For several decades, both commercial and nonprofit publishers have been charging libraries far more than individuals for the same journal. Usually, though, all libraries were charged the same rate. As scholarly journals move online, the incentive to price discriminate and the ability to do so are both growing. As a result, we are seeing dramatic growth in differential pricing. For example, unlimited usage site licenses for the online edition of the *Proceedings of the National Academy of Sciences* for 2004 will range from \$250 to \$6,600 per year, depending on the size and nature of the subscribing institution.

An example of the evolution of scholarly publishing is offered by the JSTOR project, (<http://www.jstor.org>). It is a nonprofit organization that makes available electronic versions of old issues of scholarly journals. The pricing for U.S. educational institution varies by a factor of more than four. For non-U.S. educational institutions, the pricing is more involved. It is worth quoting from the description on the JSTOR Web page:

There is no equivalent to the Carnegie Classification for grouping academic institutions outside of the United States. Nevertheless, just as we have done with the U.S. fee structure, we aim to match the contributions non-U.S. institutions make to the value they derive from participation. Through analysis of JSTOR usage and collecting patterns at participating libraries, we have developed a methodology for setting value-based fees for libraries around the world. Institutions are first placed into JSTOR classes ranging from Very Large to Very Small. Fee levels are then set taking into account the relative value of the JSTOR journal titles to the higher education community in the country as well as the local availability of fiscal and technological resources.

Note the explicit statement of the goal to charge in proportion to the value received. Note also that the estimation of this value is done partly based on studies of JSTOR usage patterns. Such usage data was simply not available in the print world. Thus more information about customers

(less privacy) provided by modern technologies leads to more price discrimination.

JSTOR is a monopolist in that its content is usually available electronically only from JSTOR. However, it does compete in the information delivery market with the print journal copies that its client libraries often have available on their shelves, with commercial information systems, and with other publishers offering content that is not identical, but which often can be used instead of that in JSTOR. The result is that the scholarly information system is becoming more efficient, with costs going down, and quality and quantity of available material increasing. In the process, though, price discrimination is becoming more important and also more explicit.

Profit-making enterprises have the same incentives to price discriminate that non-profits like JSTOR do. However, they essentially never explain in detail the rationale for their pricing decisions the way JSTOR does. Thus it is necessary to infer their goals from the price and volume information that one can obtain. There is an extensive literature in economics on this subject. In most cases enterprises in the past did not have the detailed usage information that JSTOR is collecting. Still, that did not prevent some sophisticated schemes from being developed. Many examples are presented in [30, 38]. Here I note a few additional and interesting ones.

Some instances of price discrimination are not visible to the public, except through indirect effects. For example, gasoline wholesalers in the U.S. charge gas stations prices that depend on the "zones" where the stations are located, zones that often contain just a single station [3]. The price differences within a single state approach 15%, far exceeding differences in distribution costs. They help explain why the car-owning inhabitants of New York City (who are on average more affluent than those in the rest of the country) pay far more for gas than those in rural areas of New York State. While it is not known publicly how prices for different zones are derived, one can expect that they are based on prior experience, presence of competition, and demographics of a zone, the last provided in great detail by U.S. Census Bureau.

The last few examples underline the important role that information about customers plays in making price discrimination effective. At an extreme, income tax relies on taxpayers providing detailed financial information, and is enforced by the coercive power of the government.

A very interesting example is that of U.S. private colleges. These educational institutions have high tuition and fees, typically around \$25,000 per year in 2001 among the more selective schools. (Room and board costs are additional.) However, all these schools offer financial aid to students, and in some of them, the amount spent on aid (which is determined overwhelmingly on need) comes to about half of the tuition revenues. In essence these institutions are practicing price discrimination on a massive scale, charging according to their estimates of what the students' parents can afford. Parents can preserve their full financial privacy, but at the cost of paying the full tuition.

There are several important features to this system. One is that competing colleges are all driven by the incentives to price discriminate towards very similar pricing policies. Another important factor is that the massive privacy violation involved in allocating student aid is abetted by the government. Parents usually have to fill out federal forms to obtain aid for their children. Fraudulent filings are subject to federal criminal penalties, and are not just a matter of a civil dispute between the college and the parents. Thus the government assists educational institutions in price discrimination. This is, of course, done in the interests of social welfare. However, much of the price discrimination by private institutions furthers social welfare. That is why we can expect governments' role to be ambiguous. They will be trying to respond to citizens' demands for privacy protection, and at the same time trying to facilitate sellers' price discrimination.

Public universities are also being drawn towards greater price discrimination. A widely noted article by Mark Yudof [40] explained how demographic and other trends are leading to decreased state support for higher education. At the same time, the costs of supporting educational and research activities are rising, and so is their value to society. The likely response, predicted by [40] and observed in recent rounds of budgeting, is a continued push to raise tuition. However, to continue fulfilling their core mission of educating the states' youth, financial aid will have to be provided for the needy. Thus without aiming to do so, public universities are also being pulled into increasingly discriminatory pricing.

Incentives to price discriminate are just one element that goes into price setting, and it is often hard to determine their role. For example, airlines charge extremely high fares for passengers who buy tickets just before departure. On the other hand, they offer considerably reduced "bereavement fares" for trips to funerals (at a cost in privacy, since passengers taking advantage of such fares usually have to tell who is being buried, where, and so on). Are they being charitable, are they trying to get good publicity, or are they price discriminating (since many of the funeral attendees are likely not to be too closely associated with the deceased, and so might be quite price sensitive)? We don't know, and it is possible that the airlines themselves do not know precisely how much various of these factors enter into their calculations. In economic analyses of price discrimination, a particularly sticky issue is that of "joint costs." Space constraints prevent a thorough treatment here, but it should be noted that joint costs can be used to explain many instances of what seems to be price discrimination. However, as differential pricing intensifies, it becomes clearer that price discrimination is usually the main motive. As an example, on February 27, 2002, I obtained the following prices from the Web site of Continental Airlines for advance purchase round trip tickets:

- from Minneapolis to Newark, NJ on Wednesday, March 20, returning Friday, March 22: \$772.50
- from Minneapolis to Newark, NJ on Wednesday, March 20, returning Wednesday, March 27: \$226.50
- from Newark, NJ to Minneapolis on Friday, March 22, returning on Wednesday, March 27: \$246.50

By buying the second and third tickets, and using just the first half of each, I could have saved almost 40% compared with the cost of the first ticket. Pricing structures that make such maneuvers possible are easiest to explain as coming from the desire to obtain more revenue from business travelers who are the ones most likely to make short mid-week trips. Any explanation in terms of joint costs would be very artificial.

The purchase of the second and third tickets would have violated the conditions of the Continental contract, but it is hard for the airline to enforce it. One ticket could have been bought by A. Odlyzko, the other by Andrew M. Odlyzko. As long as separate credit cards were used, and frequent flyer information was not provided on one of the purchases, Continental would not have had a way to prevent this. However, in the post-9/11 era, there is talk of setting up a unified database of travelers. Such a database, perhaps with biometric elements, probably would not do much to stop terrorism. However, if made available for commercial use, it could enable airlines to enforce their contracts. Again, a decline in privacy would enable more intensive price discrimination.

In this brief note I will not discuss legal issues, except to note that various types of price discrimination are legal. "Zone pricing" for gasoline has been upheld repeatedly by the courts, and landlords have won lawsuits filed by lawyers they refused to rent apartments to. (Thus it is legal to discriminate against lawyers!) On the other hand, many cities in the U.S. have enacted ordinances making it illegal for dry-cleaning establishments to charge more for laundering women's shirts than for men's shirts. This shows the danger in practicing price discrimination. Pigou already noted that a monopolist has to be careful in setting a pricing policy (p. 250 of [31]): "... since a hostile public opinion might lead to legislative intervention, [the monopolist's] choice must not be such as to outrage the popular sense of justice." Price discrimination is extremely tempting, and increasingly feasible, but it is like playing with fire.

3. VERSIONING AND DAMAGED GOODS

The practical problem is how to price discriminate effectively. Buyers are naturally reluctant to say how much they are willing to pay. In the past, technology for price discrimination was very limited, as purchasers had effective privacy. The standard way of overcoming this problem is through versioning, as is done with books. Hardcover books sell for more than paperbacks, far more than the cost difference justifies, and are usually available a year or so earlier. This induces the readers who are impatient or who care about nice hardcover volumes to pay more. Such versioning has been going on for ages, but it became much more noticeable and was first studied systematically in the middle of the 19th century, in connection with railroads. There is a memorable and oft-quoted 1849 passage on this subject by Jules Dupuit [12]:

It is not because of the few thousand francs which would have to be spent to put a roof over the third-class carriages or to upholster the third-class seats that some company or other has open carriages with wooden benches. What the company is trying to do is to prevent the passengers

who can pay the second class fare from traveling third class; it hits the poor, not because it wants to hurt them, but to frighten the rich. And it is again for the same reason that the companies, having proved almost cruel to the third-class passengers and mean to the second-class ones, become lavish in dealing with first-class passengers. Having refused the poor what is necessary, they give the rich what is superfluous.

Railroads did indeed behave literally the way Dupuit describes. They even put third class carriages in front of the train. The expectation was that anyone willing to deal with cinders in his hair and eyes was indeed so desperately poor that he could not be induced to pay more than third-class fare. And that is the inefficiency induced by versioning. It would have been much more efficient as well as kinder for railroads to provide better seats and simply charge passengers according to their willingness to pay. However, railroads did not have any way to determine that willingness in those days.

The incentive to price discriminate leads even to extreme versions of versioning, in which extra costs are incurred in order to make a product less serviceable. This is known as the “damaged goods” approach, and appears to be used with increasing frequency [11]. A classic example is provided by the IBM Laser Printer and Laser Printer E of 1990. The latter cost less, printed at half the speed of the former, and differed from it in having an extra chip that slowed down processing.

Versioning, and especially “damaged goods” practices, incurs costs for buyers, or sellers, or both. One of the big gains from price discrimination would be the reduction of such waste. Instead of being cruel, mean, or lavish to various customers, sellers could just charge them what they are willing to pay. Daimler could save itself the expense of designing, manufacturing, and marketing the Maybach at \$300,000 each. Instead, it could simply charge that much for a much more modest Mercedes for the folks with really deep pockets. Of course, that would upset not just the basic pricing paradigm, but the bases of our social order, where expensive toys like the Maybach car play an important role in determining status. But the savings would be immense!

Even greater savings, in both money and lives, could be achieved through increased price discrimination in medicine.

4. THE CONVERGENCE OF CAPITALISM AND COMMUNISM

The most contentious pricing issue today is that of pharmaceuticals. Health care spending as a whole is rising rapidly, and spending on drugs is rising even more rapidly. There are complaints about Big Pharma’s profits, about marketing of expensive drugs directly to the public, about special deals with physicians, etc. However, the most contentious issue is that prescription drugs tend to sell for far more in the U.S. than in other countries. Although no pharmaceutical company has admitted this publicly, the obvious rationale for this is that Americans are more affluent than inhabitants of most other countries, and able to pay more. This might

appear fair to many, but unfortunately there is no consensus on what is fair. In particular, a defense of drug pricing in the business weekly *Barron’s* elicited the following rejoinder from Congressman Bernie Sanders of Vermont [32]:

On average, for each dollar American consumers pay for prescription drugs, the Germans are paying 71 cents; the Swedes, 68 cents; the British, 65 cents; the French, 57 cents, and the Italians, 51 cents. Unfortunately, U.S. policy allows the pharmaceutical industry to maintain that price disparity. ... It’s a moral outrage that Congress continues to allow millions of elderly and chronically ill Americans to suffer and die because they cannot afford the inflated prices charged for pharmaceuticals.

Thus we have the irony that the one declared Socialist in the United States Congress complains when pharmaceutical companies engage in one of the most socialist activities possible!

Bernie Sanders does have a point in that wealthy inhabitants outside the U.S. benefit from prices lower than those charged to his poor constituents. His concern about fairness and the industry’s desire to maximize revenues could both be satisfied if pricing could be tailored to each individual, instead of being decided country by country. Thus the substantial erosion of privacy that would be involved in individualized pricing, depending on a person’s ability to pay, could satisfy several goals.

The first part of the Communist motto, “from each according to his ability” applies exactly to what unfettered capitalism attempts to do. It tries to extract more from the rich because that is where the money is. (The goal is not the same as of the second part of the Communist motto, “to each according to his needs,” though.) Moreover, both capitalism and Communism need to destroy privacy to achieve their aims. Now Communism has failed, and gone to the scrapheap of history. It simply could not deliver on its promises. Capitalism, on the other hand, survives and is generally thriving. However, it is not the unfettered capitalism of the late 19th century. While that capitalism did deliver the goods, it did so in ways that the public was not willing to tolerate. In particular, what really incensed the population was the price discrimination on railways. It offended the public sense of fairness. As a result, capitalism was tamed through government action.

5. FAIRNESS, BEHAVIORAL ECONOMICS, AND RAILROADS

The example in Section 2 shows the advantages of price discrimination in the standard economic model. Unfortunately this model ignores how people behave in practice.

As a simple example, consider Coca Cola and its experiments with vending machines that would vary prices depending on the temperature. When those experiments became public, they aroused an intensely negative reaction, and Coca Cola was forced to cancel them. In retrospect,

Coca Cola's main problem was that news coverage always referred to its work as leading to vending machines that would raise prices in warm weather. Had it managed to control publicity and present its work as leading to machines that would lower prices in cold weather, it might have avoided the entire controversy. To an economist trained in the standard model, it is clear that it does not matter whether one sets a low reference price and raises it on special occasions, or whether one sets a high reference price and lowers it the rest of the time. However, for the public, there is a tremendous difference. That is why discounts are ubiquitous, while surcharges are rare.

Some of the most striking results in behavioral economics involve the sense of fairness, as in the "ultimatum game," in which human subjects tend to act against their own best interests, and attempt to be fair to others in a zero-sum situation. The importance of fairness for public policy was brought out initially and very convincingly by Zajac [41]. Fairness turns out to have been the key reason that railroad price discrimination was limited through political action a century ago. The next three sections deal with this experience.

The key reason for carefully studying 19th century railroads is that they represent a large scale experiment with price discrimination. Technology changes rapidly, but human nature does not. Thus we should be able to pick up hints on how the public will react to an intensive dose of differential pricing by looking at how their ancestors reacted.

We can also hope to learn how price discrimination might develop by observing how it developed on railroads. Researchers in economics and marketing have come up with models which show that even when price discrimination is feasible, it might not be to the advantage of the sellers to engage in it, since it could lead to more intense competition. However, those are the usual theoretical models, and so one has to worry about their applicability. As it turns out, railroads did not want to engage in price discrimination, but could not help getting drawn into it. That is likely to happen again in our future.

6. 19TH CENTURY RAILROAD PRICING REVOLUTION

The impact of the Internet on the economy has been compared to that of railroads in the 19th century (cf. [16, 27]). There are certainly many intriguing analogies. There are also noticeable differences. Perhaps the most important was that railroads were far larger (in comparison to the whole economy) than the Internet. Therefore in looking at the impact on society, it is better to compare railroads to all of IT [27].

Railroads were the dominant industry in the second half of the 19th century. By 1880, about \$4.6 billion had been invested in American railroads. This investment (accumulated over decades) came to about 40% of that year's GDP. (The comparable percentage of today's GDP would come to \$4 trillion.)

The railroad revolution led to a pricing revolution. The stimulus came from the incentives for price discrimination

that railroad economics generated. Railroads required investments that were huge for that time. On the other hand, marginal costs were comparatively small. Even most of the operational costs (such as track maintenance) were largely independent of traffic volumes. Hence it was inexpensive to run extra trains or longer trains, with most of the additional revenue dropping straight to the bottom line. As an illustration of railroad economics in the early years of the industry, consider the statistics for British railroads for 1842 that are presented on p. 51 of [14]. The 55 lines in operation at that time cost almost \$300 million to build (compared to a national budget of about \$250 million per year, and a GDP of about \$2,500 million). Annual revenues of these railroads were \$35 million, of which \$10.6 million went to operating expenses, leaving \$24.4 as the operating margin. The financial margin of safety was not very high. Small changes in revenues produced large changes in profits. Of the 55 lines in operation, 7 were in bankruptcy or had been taken over by others after failing.

A major innovation that railroads introduced was to provide not just the basic network of rails, but a complete transportation service, involving their own stations, locomotives, and cars. This allowed them to price discriminate effectively. Because of the scale of investment that was required, they had enough market power to do this. Interestingly enough, the early expectations for railroads were that they would operate the way turnpikes did, with customers providing their own cars and locomotives. There were technical reasons for such a change, as was predicted by some early observers (see [22]). However, it appears that the possibilities for price discrimination were also very important in inducing this transition [26]. Certainly price discrimination became one of the most noticeable features of railroad pricing.

19th century railroads did not have the information technologies that would allow for "frequent rider" programs. Neither did they have a "positive passenger identification" system, complete with government-issued identification cards, that would allow them to sell non-transferable advance purchase tickets with Saturday night stay-over restrictions. What they did have were a variety of other tools for price discrimination, and they used them with abandon. Versioning was one of the main ones, as shown in the quote from Jules Dupuit earlier. There was also extensive personal discrimination. Passenger tickets in the U.S. were commonly bought from brokers, and varied widely in price.

While versioning worked reasonably well for passengers, it could not work for freight. Hence explicit price discrimination was the rule for freight from early days. This was carried out through complicated freight classifications, leading to confusion and complaints. There was plenty of scope for discriminatory dealing, with special deals for particular shippers. Charging more for short haul than long haul along the same line was prevalent. In some periods, cargo from New York to Salt Lake City was sent to San Francisco on trains that went through Salt Lake City, and then was shipped back to Salt Lake City as this saved money. Fans of "dynamic pricing" will find many of the features they advocate in 19th century freight rates, as well as others that are likely to be less appealing. The latter included rebates, including the infamous rebates that John D. Rockefeller, Sr.,

was able to collect even on his competitors' shipments. The market was dynamic, did not generate outsized profits, and, as discussed below, appeared to work very efficiently. However, it aroused great controversy.

7. 19TH CENTURY RAILROAD PRICING COUNTERREVOLUTION

The pricing revolution that accompanied the railroad era generated a counterrevolution. This counterrevolution appears to have been most intense in the United States, although there was a similar movement in Britain [27]. (Other countries were affected much less, because of heavy government involvement in their railroads.)

Railroads were initially welcomed very warmly. However, with time they became probably the most hated institutions in the country. Their popular image is conveyed by a quote from the conclusion of Frank Norris' famous novel, *The Octopus: A Story of California*:

The drama was over. The fight of Ranch and Railroad had been wrought out to its dreadful close. ... Yes, the Railroad had prevailed. The ranchers had been seized in the tentacles of the octopus; the iniquitous burden of extortionate freight rates had been imposed like a yoke of iron.

It is only a slight exaggeration to say that in the United States, the politics of the last third of the 19th century were dominated by a revolt against railroad pricing. That was certainly the focus of the Grange and other populist movements. Moreover, it was not just the farmers and the poor who were rebelling. The Chicago Board of Trade, for example, was concerned about its city being handicapped by rates for transport to New York that were higher than those from Milwaukee, even though trains from Milwaukee went through Chicago [36]. Many other powerful commercial interests were also interested in controlling railroad pricing. After intense agitation and unsuccessful attempts at regulating railroads at the state level, political action moved to the federal government. It eventually resulted in the Interstate Commerce Act of 1887, the first serious federal regulation of private business. It took many years of court cases for this act and the Interstate Commerce Commission (ICC) that it set up to become effective. In the end, though, it did revamp railroad pricing. What caused it to be set up, and what was its mission? In the words of Alfred Chandler, Jr., the preeminent business historian of the railroads [7],

The demands that brought the first permanent regulatory commission to the United States resulted directly from the railroads' discriminatory pricing policies.

An earlier writer explained in more detail what the objections were [17]:

But the fact that the charges are so low does not make *differences* in charge bear any less severely

upon business. A difference of five cents per bushel in the charge for transporting wheat a thousand miles is a small matter, taken by itself. It would be weeks before it would make a difference of one cent to the individual consumer of bread. But if a railroad makes this reduction for one miller, and not another, it will be enough to drive the latter out of business.

The pervasive price discrimination by railroads was undermining the moral legitimacy of capitalism. Unequal treatment in an opaque environment raised questions whether success was being achieved by one's merit, or through corrupt deals (as in the "crony capitalism" that many countries are accused of harboring today).

Congress did eventually respond to these concerns. The initial (and most important) sections of the Interstate Commerce Act of 1887 can be summarized as follows:

- (1) Rates to be "just and reasonable"
- (2) Personal discrimination forbidden
- (3) "Undue or unreasonable preference" forbidden
- (4) Charging more for short than long haul on same line forbidden
- (5) Pooling forbidden
- (6) Rates to be published
- (7) Impediments to continuous travel of freight forbidden

The remaining dozen or so sections were concerned primarily with administrative matters (setting up the ICC, determining procedures and penalties, and so on).

There are several remarkable features to the above summary of the Interstate Commerce Act. Only one section deals with the level of pricing. Moreover, it is vague, and basically just restates what was already an obligation of railroads as common carriers under common law, ordinary statutes, as well as the railroad charters. Of the other 6 main sections, all but one limit discrimination and "dynamic pricing."

It is now widely accepted that the passage of the Interstate Commerce Act of 1887 was not a pure triumph of the populist movement and its allies in the anti-railroad camp. The railway industry largely decided that regulation was in its best interests and acquiesced in and even encouraged government involvement. This is often portrayed as the insidious capture of the regulators by the industry they regulate (see, for example, [19]). There is certainly much evidence to support this view. For example, a modern description of the Elkins Act of 1903 says that [22]

By 1903 it had become apparent that the law relating to personal discrimination and rebating needed strengthening. The carriers themselves sponsored legislation of this sort because they were losing revenue as a result of the widespread

discrimination and departure from published rates. Yet they were unable to stop the practice without the aid of the government.

(Many more examples from contemporary sources are cited in [29].) The railroads were clearly using regulation to limit competition. Before, even while they were exploiting their customers, they were also engaged in cutthroat competition that brought many of them to ruin. Government intervention stabilized the industry. Yet this was not a simple subversion of the regulatory process. Railroads' customers did get something they cared deeply about. To be more precise, those customers got much of half of what they had been asking for, namely reasonably simple, predictable, and seemingly fair prices. What they did not get was their other demand, namely lower prices. Figure 1-1 on p. 12 of [22] and the graphs in [27] show the average revenue collected by U.S. railroads per ton-mile of freight carried. This average was dropping rapidly in the 1870s and 1880s, during the period of most intense anti-railroad agitation, and then levelled off in the late 1890s, when regulation was at last becoming most effective.

Although average prices stopped decreasing, anti-railroad agitation decreased. As often happens, it was not the level of charges, but how those charges were imposed, that mattered.

8. TRANSPORTATION REGULATION AND DEREGULATION AND GENERAL OBSERVATIONS ON PRICING

Regulation did not reduce average prices, and may even have served to raise them. On the other hand, it did lead to simpler pricing. However, it was not truly simple pricing. The economic logic of price discrimination was too powerful to overcome. Some 19th century reformers argued that it might be acceptable to allow railroads to gouge passengers any way they wished, but that freight fares should be simple and fair, since those were crucial to the smooth functioning of the economy. Yet, ironically, it was only passenger fares that were truly simplified. Most countries settled on a fixed rate per mile (or kilometer, ...), different for each class, with some special excursion, weekend, commuter, and other fares.

While simple passenger pricing did emerge from the protest movements, price discrimination for freight remained. Personal discrimination (charging different prices for the same service to different customers) was greatly reduced, although there remained various vestiges of it, for example in different charges for different localities. However, the incentives to charge more for transport of more valuable cargo were apparently too strong to be ignored. The difference was that this practice was codified, and was subject to extensive government regulation. Political attacks on railroads were replaced by regulatory and judicial hearings, with millions of pages of filings.

The rigidities and inefficiencies of the railroad regulatory regime (which was extended to truck transportation in the U.S.) grew to an absurd extent. By one estimate there were over 43 trillion rates on file with the Interstate Commerce Commission in the 1960s. It was almost a miracle when two rate clerks would come up with the same prices for any

complicated quotes. A large body of experts in setting, verifying, and challenging transportation rates developed, and they found plenty of jobs at carriers, customers, and specialized consulting firms. The inefficiencies of the system (which included fleets of trucks running empty half of the time, and transportation companies whose only substantial assets were federal trucking licenses) led to push for reform, and a freeing of the markets. The deregulation of the late 1970s and early 1980s swept most of the regulatory system away. The government, prodded by reformers, decided that there was enough competition between railroads, trucks, airlines, pipelines, barge lines, and other carriers to let a relatively free market operate. There is still some government oversight (through the Surface Transportation Board) to prevent extreme cases of carriers exercising market power, but it is far more limited than before.

The general assessment among experts who have studied the effects of deregulation is that it has been a great success. Average prices have fallen in all industries. For example, inflation-adjusted rail rates are down 45% since 1984 [35]. Yet not everybody is happy. The public sense of fairness is offended by findings such as that on railroads, "captive shippers commonly pay rates 20% higher than shippers with competitive alternatives" [35].

Railroad freight rates are invisible to the general population. On the other hand, airline fares are a frequent topic for conversation and complaints. There is extensive statistical evidence that deregulation has been a success. Even though technological progress is slow, average fares are down, planes are flying fuller than before, and seats are usually available even at the last minute. However, what the public talks about is unhappiness with the bewildering variety of constantly changing fares, travel restrictions, fares to an intermediate city costing more than to a more distant one (even when one flies on the same plane), and so on.

Airline yield management is spreading to trains, hotels, and even golf courses. This is not applauded by the public. A story about the privatization of British railroads spent as much time discussing the annoying pricing structure that is evolving as the lower quality of service [9]:

But perhaps the most baffling aspect of British rail travel is the price. ... Fare structures have become a tangle of elusive discounts and incentives for early booking that have widened the gap between standard and first class passengers – but probably united them in complaining about poor service.

9. OVERT OR COVERT PRICE DISCRIMINATION?

The incentives to price discriminate are growing, while the means to price discriminate are exploding, as technologies erode privacy and enable more sophisticated controls. Therefore enterprises will likely be pulled towards differential pricing. It may not lead to greater profits, but the experience of the railroads in the 19th century suggests that the competitive dynamic of the marketplace will not allow them to refrain from trying. Will their customers accept overt price

discrimination? The business world operates that way, with extensive use of differential pricing. Perhaps individuals in their private lives will also learn to live with it. As the economy evolves, our discretionary incomes grow, and people may accept that purchasing is a game. Harrah's casino has developed an advanced information system it uses to motivate its customers to spend at Harrah's. It relies on detailed information about each customer, and incentives tailored to each one [5]. At least some customers appear to accept this well:

[One customer] says she's not put off by Harrah's "Pavlovian" marketing. "A gimmick to get me to spend more money?" she asks rhetorically. "Why of course it is."

However, it is more likely that, when subjected to a constant barrage of differential pricing, people would do what they did a century ago, and rebel. Certainly their reactions to variable pricing by Amazon.com or Coca Cola do not suggest any greater tolerance than their ancestors had shown. Pigou's warning (Section 2) to sellers about legislative intervention is likely to be still valid. Therefore the best strategy for sellers will be to hide their differential pricing.

10. THE MANY WAYS TO SKIN A CAT, OR HOW TO HIDE PRICE DISCRIMINATION

How does one conceal price discrimination? The basic way is to avoid simple cash pricing. Make an offer where the price is a combination of cash and frequent flyer miles, say. Make individualized offers that supposedly reflect the prospective purchasers' past dealings with you. There are many variations, and they are already being tried in the marketplace.

There are also several systematic ways to practice hidden forms of price discrimination, based on bundling. The main reason bundling is practiced so widely is that it allows sellers to take advantage of uneven preferences among buyers for the goods in the bundle. (For references to the extensive literature on bundling, see [13].) Thus bundling serves the same purpose as explicit price discrimination in reducing consumer surplus. Consider an example of site licensing, which is really a form of bundling. Suppose Alice has a software package to sell, and a company she would like to sell it to. Of the company's 1000 employees, 900 have no interest in Alice's program, 10 of them are willing (or their bosses are willing) to pay \$10 apiece, 10 are willing to pay \$20 apiece, and so on at each \$10 price break, up to 10 who are willing to pay \$100 apiece for the program. If Alice knows these valuations, and has to sell to individuals at a fixed price, the optimal choice for her is to charge either \$50 or \$60 for her package. In either case she will get \$3,000. However, the collective valuation of all the employees in this company is \$5,500, so she should be able to sell the package for unlimited use by every one of the 1,000 employees for \$5,500. Thus by selling a site license, Alice will actually do as well as if she could charge each individual that person's valuation for her package. At the same time, she will appear to be offering the company a bargain. The package, which might sell to individuals outside for \$50 per copy or more, will be available at a cost per eligible employee of just \$5.50.

The conclusion is that there are ways to achieve the same ends as explicit price discrimination without appearing to do so. Furthermore, methods such as site licensing have additional advantages, such as increased usage and network effects. A brief summary is given in [25].

11. CONCLUSIONS

The general conclusion is that in the Internet environment, the incentives towards price discrimination and the ability to price discriminate will be growing. Sellers will be increasingly tempted to engage in differential pricing. However, such practices are fraught with danger, since the public is likely to resent them intensely. Therefore the stress is likely to be on finding ways to hide price discrimination. This means that techniques such as DRM are likely to be used only in mild forms, and instead preference will be given for various bundling strategies, especially personalized bundles. However, privacy will continue to erode, since intimate knowledge of consumer preferences and willingness to pay will be of advantage in creating those bundles, and will often provide crucial competitive advantage to sellers.

Governments are likely to play an increasing role in pricing. The temptation for companies to push their differential pricing to the extremes of public acceptability is likely to lead to sufficiently negative reactions from time to time that governments will get involved in setting rules. Moreover, since prices in an environment of low marginal costs will be seen to be almost completely arbitrary, there will be a temptation for the public to demand regulation. Governments are also likely to continue playing an ambiguous role, in order to protect the welfare-enhancing effects of price discrimination. Thus on balance we should not expect governments to protect privacy. The most they are likely to do is to set rules on how private information can be used in setting differential prices (as they already do in insurance, for example).

In general, the economic advantages of price discrimination are and are likely to remain in direct conflict with public dislike of such practices. Hence it is not likely that there will be an easy resolution to the problem, and privacy erosion and differential pricing will continue to be contentious public issues.

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