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# PRICING ON THE INTERNET

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*It is often claimed that e-commerce has created a more competitive environment by encouraging the entry of new online firms and by enabling buyers to search easily for the lowest prices. The limited evidence that exists paints a mixed picture. Many online markets are advertising- and technology-intensive, creating a tendency towards growing concentration. Price search is imperfect and firms can dampen price competition by increasing product heterogeneity and switching costs. In many sectors, online firms may come to acquire some market power. We look at the forms of pricing that are likely to emerge in such markets, including the greater use of price discrimination and auction-like trading arrangements.*

## I. INTRODUCTION

Even though e-commerce accounts for only a small fraction of total retail transactions, it has had a noticeable impact on pricing behaviour and the nature of competition in retail markets. For homogeneous goods, such as books and CDs, the arrival of online retailers is said to have created an extremely competitive environment putting downward pressure on prices. There has been an explosion in the amount of free information available on the Internet. Financial data that was quite costly only a few years ago can be downloaded at no charge. Online editions of newspapers and journals, and a lot of computer software, are available free. The venerable *Encyclopaedia Britannica*, once marketed as a lifelong personal investment, is now accessible as a free online service supported by advertising. This paper examines the nature of competition and forms of pricing that are likely to emerge with the growth of the Internet.

The observation that e-commerce has created a more competitive environment is typically based on two premises. The first is that the Internet alters the structure of costs in many industries: it is claimed that online firms have lower set-up costs, and also lower marginal costs of production and distribution, than conventional firms. This promotes entry of online retailers in sectors that were previously

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concentrated. The second premise is that the Internet facilitates a dramatic reduction in consumers' search costs and in the cost of switching between rival sellers. Browsing a distant store's website to check prices is easier than visiting the store. 'Shopbots'—automated software agents that simultaneously query many stores for price information—enable cheap and effective price comparison, especially for homogeneous goods. The ability to purchase online makes it easy to respond to discovered price differentials: switching from one online seller to another is easier than travelling from one store to another. Thus, the argument goes, by eliminating the usual frictions in markets, e-commerce has increased the intensity of competition. Together, these developments should take markets closer to the theoretical model of perfect competition, or at least to the intense price competition of the Bertrand variety, with prices close to marginal costs.

However, the long-term outcome may not be so competitive. As is apparent to anyone watching the so-called New Economy, the premise that virtual firms have a cost advantage over their old-economy rivals is not borne out by facts. While the cost of setting up a website is relatively low, success in online markets requires substantial investment in technological and organizational infrastructure. There may be substantial economies of scale in these, limiting the scope for competitive entry. Further, to establish and preserve a brand name on the Internet requires substantial expenditure on advertising, and such costs tend to rise endogenously in online markets. As Sutton (1991, 1998) has argued persuasively, such characteristics typically make for high industry concentration in equilibrium.

The winner-takes-all aspect of the Internet encouraged excessive entry and aggressive pricing in early years. However, strategies such as 'penetration pricing'—selling goods at heavily discounted prices in order to build a customer base—have proven to be costly and short-lived. What many Internet entrepreneurs (and the venture capitalists funding them) believed to be the one-off cost of acquiring customers, was not quite so. With hindsight, it appears that customer bases could be preserved only by sustained advertising expenditure and repeated price discounts. Steady operational losses have led to numerous bankruptcies and gradual consolidation in many online markets. We conjecture that in most online sectors only a handful of firms will survive what is, in essence, a war of attrition.

Even if only a handful of firms survive, should the reduction in search and switching costs not create a frictionless environment, and result in a competitive, Bertrand-like outcome? In some sectors, intense online competition has exerted downward pressure on prices. Brown and Goolsbee (2000) find that online price comparison has led to a marked reduction in prices in the retail insurance industry, and Goolsbee (2000) reports similar findings in retail markets for computers. But, more generally, the answer to this question is not straightforward. A part of the difficulty lies in that the Internet increases the information available to sellers as well as buyers. The market outcome, and whether average prices rise or fall, depends on the *relative* ability of each side to manipulate and use that information to their advantage. There are reasons to believe that online prices may not be significantly lower. First, while price-comparison services help consumers to search for the lowest price, search is far from perfect. Sellers can sometimes reduce the efficiency of price search through deliberate obfuscation. Second, the Internet makes it easy for online retailers to track their rivals' price movements and to react to them rapidly: in some circumstances this makes implicit collusion more likely, resulting in higher prices on average. Third, the Internet allows sellers to collect a remarkable wealth of information about their existing and potential customers: where retailers have some market power, this enables better price discrimination, with possibly higher prices for some buyers. Fourth, we expect that retailers will find devices to raise switching costs endogenously, through loyalty schemes and deliberate product differentiation: this may allow them to charge higher prices in the future.

We review these developments for various categories of goods and services that have migrated to online markets. Section II of this paper looks at online markets in homogeneous goods such as books, recorded music, and branded consumer durables. In such markets, the Internet has spawned a class of online intermediaries in competition with the

traditional retail intermediaries. Precisely because these goods are homogeneous, they are amenable to automated price comparison. We examine how price comparison affects competition and prices in these markets and assess the existing evidence.

Section III considers our second category of goods, namely information goods, such as downloadable software, online newspapers, information, and entertainment services. Given that these products can be digitized and transmitted at low cost over the Internet, we expect that, increasingly, these will be distributed through online channels. Where it is difficult to make users pay for these, producers will try and generate revenue indirectly, through advertising. We expect that sellers will attempt to increase product differentiation, and customize their product offerings by bundling elements that match the observed characteristics of individual buyers. Such strategies may provide at least some market power to retailers.

Section IV reviews the pricing strategies that firms use in the presence of market power, and examines the efficacy and use of these strategies in online markets. Section V looks at online auctions: when the seller does not know buyers' valuations, auctions generate more revenue than selling at posted prices. The Internet has extended the use of auctions even to low-value items, by removing the need for buyers and sellers to congregate at a particular location and time. The use of auction-like trading arrangements is expected to grow, especially in online business-to-business transactions. Section VI concludes.

## II. ONLINE MARKETS FOR HOMOGENEOUS GOODS

Books and music CDs are typically published by relatively large firms and sold through retail intermediaries. The sales channels are usually non-exclusive in that most retailers sell the products of multiple publishers. Books and CDs are homogeneous goods and hence uncertainty about the quality of the good is not a strong deterrent to purchasing them remotely. Not surprisingly, they were among the first products to migrate to online markets. The new intermediaries claim to have a cost advantage over their bricks-and-mortar rivals. The Internet eliminates the need for costly retail display space, and by consolidating inventory in central warehouses, reduces the cost of distribution. Online book retailers compete with each other, and increasingly with conventional bookstores. Even though the market share of online retailers remains small—Goolsbee (2000) finds that the online sales of books amount to no more than 5 per cent of the industry total—it may grow substantially over time. Similarly, online markets in other relatively homogeneous goods, such as branded consumer durables, generic goods such as computer hardware and memory modules, airline tickets, and simple financial products such as insurance and mortgages are expected to grow.

At the same time, precisely because these goods are standardized, they are amenable to automated price comparison. Books are identified uniquely by their ISBN number, and most consumer durables by their manufacturer's product code, so that it was relatively easy to devise search engines for these. BargainFinder.com was one of the early examples of such a service: someone who wanted to buy a particular book or CD could use BargainFinder's software to query various online stores in real time and compare prices, in order to locate the cheapest retailer. Now there is bewildering range of competing price-comparison services. In the USA, mySimon.com and dealtime.com are among the market leaders, but in addition there are evenbetter.com, bottomDollar.com, addALL.com, and numerous others. There are many dedicated price comparison services for specific markets, such as expedia.com and travelocity.com for the travel industry.

There are two categories of price comparison sites. Price-search agents work by collecting their data from various retailers' websites. In price-listing services, such as Pricewatch.com, retailers voluntarily choose (or even pay) to list their prices on a common, searchable, database. Early comparison engines were simple and compared retailers in terms of a single attribute: the quoted price. Over time, they have become quite sophisticated, and can rank rival retailers by multiple attributes—for instance, the quoted price, the final price inclusive of packing and delivery charges, the speed of delivery, and previous customers' satisfaction ratings. The evolution of XML (extensible markup language) and other common standards for organizing infor-

mation on the web is expected to make such multi-attribute search and price comparison even more reliable.

In theory, the ability to search for the lowest price, combined with relative ease of switching from one online seller to another, should create intense price competition. If online retailers also have cost advantages over conventional retailers we should expect, *a fortiori,* that prices in online markets would be lower than in conventional stores. Further, any price dispersion that exists in markets for homogeneous goods—the coexistence of different prices for the same good—is usually attributed to information imperfections and market frictions. If online search costs and switching costs are low, we should expect that firms with high prices will not survive. Therefore, price dispersion should be lower in online markets.

Existing evidence does not support these predictions. Many early studies found that average prices in online markets were higher than the prices in conventional stores (see Bailey, 1998, for instance). More recent studies suggest that some online markets may be cheaper now: Brynjolfsson and Smith (2000*a*) find that, for books and music CDs, online stores are cheaper than conventional stores by a margin of 9–16 per cent. This trend towards eventually lower prices on the Internet is usually described in terms of the growing maturity of online markets. On the issue of price dispersion, the results are more surprising. Almost all studies of pricing in online markets report substantial and *persistent* price dispersion. In their study of 32 online book retailers, Clay *et al.* (2000) found that the standard deviation of online prices for books, expressed as a percentage of their average price, varies from 17 to 28 per cent. Brynjolfsson and Smith (2000*a*) found that, in their data, the difference between the lowest quoted price and the tenth lowest price averaged as much as 33 per cent for books and 25 per cent for CDs. And, equally surprisingly from a theoretical point of view, they find that even though books and CDs are supposedly homogeneous, the firms that have the lowest price do not have the largest market shares. Amazon.com is typically 10 per cent more expensive than the cheapest retailer, and yet dominates the online book market (by some estimates its market share is over 60 per cent).

### (i) Heterogeneity of Product Bundles

There are various explanations for these findings. The simplest is that these products are not quite homogeneous, but differ in overall package of bundled services that accompany the transaction. These include the speed of delivery, store policy on returning defective or unwanted items, and the overall quality of the 'online shopping experience'. For instance, Amazon provides detailed book reviews to buyers. It also provides personalized recommendations to its registered users, based on 'collaborative filtering' of their purchase history (by detecting patterns in purchases and reported preferences across people, and using these to suggest titles of interest). To the extent that buyers come to value these bundled services, they may be willing to pay for them. That could explain why Amazon.com has a dominant share of the online book market despite the fact that its prices are not always the keenest.

Further, the physical separation of buyers and sellers in online markets, and the temporal separation between paying for a good and receiving it, creates a potential problem of trust. Buyers' purchase decisions may be distorted by the lack of trust in some retailers. In such situations buyers may be prepared to pay a premium for the security of buying from a reputable store. Indeed, low prices are often dismissed as too good to be true. Brand names serve as a signal for reliability in the non-contractible aspects of product bundle, but to build an online brand name requires considerable advertising expenditure. Online reputations are also fragile—online chat groups enable buyers to share their unhappy shopping experiences with others quite readily—so that recurrent expenditure may be necessary to preserve brand reputation. In equilibrium, only a handful of retailers may be able to sustain these levels of expenditure.

### (ii) Switching Costs

To explain price variation in terms of heterogeneity of the product bundle is convenient but is, at best, a partial explanation. There is also the possibility that switching costs are not as low as they are claimed to be. In contrast to the simplicity of buying something in a conventional store, purchasing at an online store requires an individual to fill out multiple forms

and create user identities and passwords—in effect to interact with a complex database. If revisiting an online store can economize on these time-consuming tasks, switching costs are indeed positive. If familiarity with a particular electronic storefront is valuable to buyers, it may result in what has been described as 'cognitive lock-in'. As Beggs and Klemperer (1992) show, high switching costs tend to result in higher prices. In the future, software innovation may reduce such switching costs—a range of software and services exist that can store your essential personal data on your own computer and 'port' these on demand to expedite transactions with new retailers—but so far their take-up has been low.

In addition, we should expect online retailers to create devices that deliberately raise the costs of switching to their rivals.[2] If so, switching costs are, to some extent, endogenously determined. Loyalty schemes are one such time-honoured device. Just as frequent-flyer programmes allowed airlines to mute the intensity of price competition, we expect that online stores will resort to frequent-buyer discounts: to be really effective, these would be non-linear with proportionately higher discounts for the most loyal customers. Online retailers have adopted other tactics, too, with the same intent. For instance, Amazon.com rewards its loyal customers with additional services such as expedited delivery and has developed software that enables registered users to complete their purchase transactions with a single click. Drugstore.com offers guidance on potential adverse interactions between drug prescriptions, but only to those users who buy *all* their drugs from their online store. To the extent that buyers come to rely on these services, they serve as a deterrent to switching.

### (iii) Imperfections in Search

A third explanation is that, as yet, search and price comparison is not very comprehensive or effective.[3] Johnson *et al.* (2000) find that many online buyers do not search at all, and even among those who search, sometimes the intensity of search *declines* with user experience. For instance, prospective buyers often use search to identify a cheap travel agent and, having found one, tend to stick with that agent rather than compare prices repeatedly. These facts suggest that search is costly and/or not very valuable.

Further, retailers may be able to obfuscate the search process. As early shopbots compared stores on the basis of list price alone, retailers would often quote low prices to attain high rankings in price comparisons, but then add unreasonably high charges for shipping and handling. Search engines have improved and now quote the price including all handling charges. A second, more brutal, obfuscation tactic used by some retailers is to prevent comparison engines from accessing their price data. This tactic is somewhat self-destructive—by blocking search you lose potential customers yourself—but nevertheless it is a common practice and it does reduce the overall efficiency of search. A third tactic is to create spurious product differentiation by creating slight variations in the product bundle (or its product code) to confuse search engines. Lastly, Ellison and Ellison (2001) find evidence of 'bait-and-switch' tactics in the market for computer memory modules. Firms offer inefficiently low quality products at a very low price to score highly on price comparisons. This enables them to attract customers to their website, whom they then try to convince to pay extra for the better quality product they really wanted. In essence, this tactic makes search engines less effective in comparing prices of better-quality memory modules. If search is imperfect for these reasons, price dispersion may persist. Over time, search engines may improve, but then so might the obfuscation tactics of online retailers.

To understand the role that price-comparison agents will come to play, we need to understand the implications of search efficiency for the agents themselves. To survive as independent businesses, price comparison sites must generate revenues. Potentially, they can do so through advertising revenue and through charging buyers and sellers for the use of their service. In practice, most search engines offer their service free to buyers while charging a fee to their sellers, either in the form of

[2] See Odylzko (1996) and Brynjolfsson and Smith (2000*a*) for a discussion of this and other market frictions.

[3] For a discussion of the effect of comparison engines on shopping behaviour, see DeLong and Froomkin (2000) and Brynjolfsson and Smith (2000*b*).

commissions on referred sales, or fees for inclusion in the listings.[4] Here there is a conundrum: a price-comparison service, if effective, will intensify price competition and reduce price dispersion. In the limit, if there is no price dispersion, search is useless. But, in a world in which consumers do not search, sellers are unwilling to pay for listings or referral fees. Further, no retailer will choose to advertise on a search engine that consumers do not use. Thus, a price comparison service that was very effective in terms of intensifying price competition and reducing price dispersion would undermine all its sources of revenue. Our limiting case is somewhat extreme but the message is simple: for price-comparison agents to survive as profitable enterprises, it is important that price dispersion is not eliminated altogether.

Baye and Morgan (2001) propose one possible resolution of this conundrum.[5] Using an approach similar to Varian (1980), they see dispersion as the outcome of deliberate price randomization by firms. They view price-comparison sites as 'information gatekeepers', that are supported by fees imposed on buyers and/or sellers. Sellers must choose either to sell exclusively in their own locality, or to list their price on the gatekeeper's site to attract buyers from other localities as well. Their model has an equilibrium in which the gatekeeper chooses its fee structure so that all buyers access its price-comparison services, sellers randomize over the decision to list on the site and also randomize over the advertised price. At the equilibrium randomization, each seller is indifferent between listing and setting any price between the Bertrand price and the monopoly price, or not listing and charging the monopoly price in its own locality. As a result of the mixed strategy adopted by the sellers, the equilibrium outcome displays price dispersion.

### (iv) Implicit Collusion

Online prices may also be higher than expected due to the greater possibility of implicit collusion in online markets. This enhanced possibility may be the result of changes in the market structure. Clay *et al.* (2000) find that online book retailing is more concentrated than conventional book retailing; it is likely to become even more so with the proposed takeover by Amazon.com of the online operations of Borders Books. In the travel industry, for instance, the arrival of large online travel intermediaries has made it harder for small independent travel agents to survive. In the USA, the number of independent travel agents has fallen by 15 per cent since 1997, and this tendency may be exacerbated by the airlines' decision to reduce commissions on ticket sales. The major US airlines have teamed up to launch Orbitz.com, a common retail platform, and European airlines have expressed similar interest in setting up a commonly owned online travel agency. Even the airlines realize that such steps are reminiscent of early price-setting cartel associations and have issued various 'clarifications' to divert regulatory scrutiny.

In online markets where only a handful of firms survive, the nature of information flows on the Internet can also increase the likelihood of tacit collusion. In particular, the Internet alters the speed with which firms can monitor and react to their rivals' prices. In conventional markets retailers do not respond immediately to their rivals' price cuts because it takes time to learn about price cuts and the menu costs of changing prices prohibit frequent changes. In online markets, the story is different. Menu costs are low because prices can easily be changed in a central database. A firm can observe and react to a rival's price changes in a few minutes. Indeed, the process can be automated by using software that tracks the rival's price and uses simple algorithms to respond to it. An online firm may use this facility to match its rival's prices, dropping and raising its price in tandem with its rivals. Price matching may well become the norm in some online markets. While this seems like a pro-competitive development, its real effect on prices is often perverse. The essence of price competition lies in that if a retailer drops its price, it expects to gain market share: it makes sense to reduce prices as long as the gain of a larger market share outweighs the loss due to lower price. If your rivals match your price cuts instantly, a price reduction does not increase the market share but results in lower profits on existing, infra-marginal sales: the

[4] Some shopbots, such as mySimon.com, offer 'priority listings' to retailers that pay premium fees. As a result their price comparisons are not always unbiased.

[5] For other approaches, see Ellison and Ellison (2001) and Kephart and Greenwald (1998).

incentive to lower prices is thereby dampened. On the whole, the widespread prevalence of price matching could result in higher prices in the aggregate.[6]

## III. ONLINE MARKETS FOR INFORMATION GOODS

The Internet is eminently suited to online distribution of information goods—the list includes computer software, recorded music and entertainment, information services, archival databases, electronic newspapers, and scholarly journals, among others. These goods can be stored in digitized form and distributed at relatively low cost over the Internet. It is expected that improvements in the transmission capacity—the bandwidth—will allow feature-length movies and other entertainment products to be readily downloadable in the near future.

Information goods differ from conventional goods in the structure of their costs. Producing an information good is costly, but reproduction is relatively cheap. The cost of producing a Hollywood feature film runs into millions of dollars, but it is possible to make near-perfect copies of the first print at negligible cost—not much more than the cost of the physical storage medium. Or, to put it another way, information goods have relatively high fixed costs of production but their marginal cost is close to zero. The problem is that if the marginal cost is indeed zero, or close to zero, pricing based on marginal cost is not feasible. A firm that sets its price at marginal cost will not be able to recover its fixed costs.

A second difficulty arises from the fact that if information goods are distributed in digital forms, they can be copied and redistributed with relative ease. Napster.com distributed software that enabled a subscriber to search through the hard disks of other subscribers' computers to locate a piece of music in MP3 format, and access it on demand. As long as any single subscriber had access to a piece of music, others could download and listen to it without paying for it. This is the familiar problem of non-excludability: that access cannot be denied to people who have not paid for the good. The problem exists even if information goods are sold conventionally, on physical media, but the Internet extends the scope of such replication. It is far easier to make multiple copies of an electronic book and to distribute it online than to make illegal photocopies of its paper equivalent.

Other things being equal, the ease of replication creates an argument against the use of electronic channels for distribution: the existence of electronic copies may inhibit further sales and erode revenue. But we expect that producers of information goods will invest in developing better technologies for exclusion (such as encryption), and for detecting piracy (through digital watermarks, etc.). We also expect them to lobby in favour of legislation that preserves and extends their intellectual property rights to cyberspace. For instance, a consortia of music publishers has had some success in this: recently, the US Supreme Court asked Napster to remove all copyrighted material from its database.[7]

While a combination of technical development and legal challenges helps to protect property rights in archival material, for some categories of information goods there is an alternative means of preserving revenue: namely, obsolescence. Academic publishers have long appreciated the benefits of producing revised editions of textbooks to generate fresh sales in markets saturated with second-hand copies of the existing edition. Likewise, by releasing new, improved versions of computer software at shorter intervals than before, software publishers will aim to generate new sales, and reduce the 'drag' of pirated versions in circulation.

The music industry is also experimenting with the idea of selling music on a subscription basis. Groups of publishers have teamed up to launch two new online services, pressplay and Netmusic, that will allow subscribers to download new music for a monthly fee. While subscription-based services have

[6] We must not overstate this possibility as it depends quite crucially on the precise form of price-matching behaviour. If firms can price-discriminate, price-matching guarantees may be implemented only for buyers who are informed about rivals' lower prices. Corts (1997) finds that in some cases, discriminatory price matching may result in *lower* prices in the aggregate.

[7] While there are numerous successors to Napster—Gnutella, Aimster, etc., with 'swap' programmes that make it hard to trace the shared use of files—it is too early to write off the publishing industry: it has far too much to lose and deep pockets to finance long legal battles.

had some success in satellite broadcasting, their success in the music industry depends quite crucially on the technological ability to prevent unauthorized duplication.

Where it is difficult to make people pay for information goods, providers may seek to generate revenue through indirect means. Just as private network television came to rely on paid advertising to support its services, many providers of information goods (online *Encyclopaedia Britannica* included) hope to profit through advertising revenues. Sometimes free provision of information goods may enable sellers to raise revenue through sales of related goods. Free electronic access to a text-based document sometimes encourages the sale of its print version, which may be more convenient to read. Economist.com allows online browsers to sample some of its articles each week: this may increase sales of its print edition and boost revenue from selling access to archives of past articles.

## IV. ONLINE PRICING IN THE PRESENCE OF MARKET POWER

Information goods are usually characterized by some degree of product differentiation, providing at least some market power to the seller. In section II we argued that online sellers, even of the so-called homogeneous goods, may come to acquire some market power. We examine some strategies that sellers with market power use to increase profits, and ask how the migration of transactions to the Internet affects the use of these strategies. While our discussion is in terms of information goods, it is relevant to any online market in which the seller has market power.

### (i) Price Discrimination

Consider a monopoly seller of an information good, facing buyers who differ in their valuation of this good. A single posted price would not maximize the seller's revenue in such cases. A better outcome, from the seller's perspective, would be to set each buyer a price equal to his or her maximum willingness to pay for the information good.[8] This would quite naturally involve price discrimination: charging different prices to customers. For price discrimination to be feasible, the monopolist needs to know each consumer's willingness to pay, or at least be able to sort customers who are willing to pay more from others who are not. At the same time, it needs to segregate the markets, to prevent people who are offered the good at a low price from reselling it to others at a higher price.

One time-honoured way to sort customers is to discriminate on the basis of some observable consumer attribute that is correlated to their willingness to pay. Airlines offer discounted airfares to students on production of student IDs: here, student status is correlated with lower willingness to pay. Publishers of college textbooks often set lower prices in developing countries: they use geography to sort and segregate their markets.

How does the Internet affect the ability of firms to use discriminatory pricing? Some forms of price discrimination begin to fray with e-commerce. For instance, it is harder to use geography as the basis for discrimination. Geographic location does not matter when people order online, provided that delivery costs are not too sensitive to distance and if there are no legal and tariff restrictions on the free movement of goods. If people can buy cars online, and if there are no restrictions to transporting them within the EU, the geographic price discrimination practised by European car manufacturers is likely to decline.

However, there are other ways in which the Internet encourages price discrimination. For one, online sellers may come to be remarkably well informed about their potential customers and their characteristics. Online retailers can identify their customers through 'cookies'—these are small bits of information lodged on the user's computer that allow the retailer's computer to 'recognize' a returning customer. It is then possible to match the customer to his previous history of browsing and purchases at the site. And it does not end there: once you provide the seller with a delivery address, they may be able to use existing third-party databases to get a better idea of the market value of the house you live in, the

[8] In practice it is hard for the seller to ascertain a buyer's willingness to pay; even the buyer may not know his or her valuation prior to experiencing the good. We should expect greater use of tactics such as free samples and previews.

average income in your neighbourhood, and so on. They can determine the kind of software you use to access their site and the quality of your Internet connection: these may well be correlated with income. Armed with this wealth of information, online sellers can customize prices for each buyer. The nature of online interaction permits this: prices can be personalized just as 'pageviews' are. This is much harder to do in a conventional store where prices must be posted publicly.

How would an online seller want to use this ability? For one, it could charge a low price to attract new customers, while extracting a higher price from loyal customers (i.e. those who are locked in). Indeed, it has been reported that Amazon.com has attempted such price discrimination, quoting higher prices to existing customers (see BBC, 2000). The helpful advice offered by the ever-alert hacking community was to conceal your identity by blocking Amazon's cookies from your browser. Amazon's spokesperson dismissed this charge and argued that they vary prices randomly as a part of their normal experimentation, but this is not quite credible. In the long run it is only to be expected that online retailers will try to increase their revenue by mining their consumer databases.[9]

Of course, successful price discrimination requires market power. To what extent would the growth of price-comparison services erode this market power? The possibilities here are quite interesting. Existing technology allows retailers to distinguish between customers referred by price-comparison sites and those that access them directly. To the extent the former are more likely to be price sensitive, it could set a lower price for those referred by shopping agents, while charging a higher price to customers who approach them directly.

We should also expect more temporal price discrimination: price discrimination based on the timeliness of a good or service. Such price discrimination is not peculiar to online markets. The early hardcover version of a novel costs significantly more than the paperback version released months later: the price differential does not reflect the cost of binding but is a form of price discrimination. Movies can be seen more cheaply through video rentals if you are prepared to wait a few months. Such temporal price discrimination is not easily undermined by e-commerce (though illegitimate e-commerce, say violations of copyright laws, restricts its depth), and may even grow.

We should also expect an increase in a familiar tactic called 'versioning'. For instance, online financial information services are available in different versions. Real-time stock quotes are an expensive service, typically bought by market traders, while time-delayed quotes are available free. Computer software can often be bought in 'student' and 'professional' versions; the student version is similar to the professional version with some features disabled, and is sold at a significantly lower price. Such versioning is useful when the seller cannot distinguish between customers' willingness to pay on the basis of any observable characteristic. It increases revenue as long as the consumers with a high willingness to pay are the ones who are prepared to pay a premium for quality. By allowing buyers to self-select from a range of versions offered at different prices, the seller can sell at a high price to the quality-conscious buyers and, at the same time, capture some revenue from the rest, by selling them a cheaper, inferior version. Interestingly, as Deneckere and McAfee (1996) point out, it may be profitable to degrade the quality of the inferior version deliberately, as this may persuade some consumers, on the margin of choice between two versions, to upgrade to the expensive one. Reducing the functionality of the student version of software may persuade some buyers to switch to the more expensive professional version, just as reducing legroom in the economy sections in aircrafts makes affluent customers more inclined to upgrade.[10]

Why do we expect more frequent use of versioning in online markets? In general, while selling multiple versions increases revenue, it also increases distribution costs. The optimal number of versions to carry is quite sensitive to this trade-off. When selling goods online, it is relatively cheap to produce and 'stock' multiple versions. Other things being equal, we should expect an increase in versioning.

[9] At the same time, there is the emergence of sites such as Safedoor.com that help customers to anonymize their transactions.

[10] See Varian (2000) for an elaboration of this point.

**Table 1**
**Individuals' Willingness to Pay for Articles**

| | Article 1 | Article 2 |
|---|---|---|
| Individual A | £2 | £3 |
| Individual B | £3 | £2 |

### (ii) Aggregation of Goods

Many of the things we buy are bundled goods. A daily newspaper or a news magazine is a bundle of many articles and reports on various subjects, such as news, sports, and financial information. You may care a lot for some of these and not much for others. Similarly, this issue of the *Oxford Review of Economic Policy* is a bundle of many articles on the Internet. These are bundled together because, in the editors' opinion, the articles are linked by a common theme. But, in addition, the technology of production, printing, and distribution makes it economical to sell these articles as a bundle rather than individual articles. The aggregation of goods and services extends further. Instead of buying individual issues of this journal, you may choose to buy an annual subscription, thus bundling the purchase of issues over time.

Electronic distribution of information goods creates the possibility of novel forms of pricing. The structure of costs is different for the online and print versions of this journal. If journal articles can be downloaded electronically, the economies of scale and scope that make it worthwhile to sell articles in bundled form are less important. Might it be sensible to allow readers to buy individual articles, each for a small fee? Abstracts could be made available free, as they would serve to advertise the contents of the article (but we may need greater adherence to truth in advertising, a feature that abstracts often lack). The development of micropayment systems to enable small financial online transactions should encourage such unbundling. Indeed, why buy even an entire article? Get it page-by-page, paying initially for only the first page, and then for the second page only if the first page seems worth it.

While the Internet creates the technological possibility of unbundling, it may not always be in a seller's interest to do so. Bundling usually allows the seller to extract more revenue than selling the individual components separately. To understand this in the simplest possibly way, consider an electronic journal that has only two articles to sell and a potential readership of two individuals. Assume that electronic delivery of articles is costless, and the potential readers place different valuations on the articles, as in Table 1.

If the publisher was aware of these valuations, it could personalize prices, making each individual pay exactly her valuation for each individual article. Without information on individual valuations, such price discrimination is not possible. Suppose the publisher knows only the distribution of the valuations in the population for each article. In this circumstance, selling the two articles as a bundle may be more profitable than selling them separately. To see this, consider the publisher's choices when setting the optimal price for Article 1. If the price is set at £3, only one individual would buy it, while at the lower price of £2, both individuals would buy it, increasing revenue to £4. Likewise, Article 2, if sold individually, is optimally priced at £2, yielding £4 as revenue. Total revenue from selling both articles separately is £8. However, selling the two articles as a bundled product can increase profits. As each individual is prepared to pay as much as £5 for the two articles together, selling the bundle for £5 would increase revenue to £10. Bundling enhances revenue in this case because, while the readers have heterogeneous preferences for individual articles, their valuations for the bundle are similar. The underlying argument is quite general. By the law of large numbers, as long as individuals' valuations are not correlated, their valuation of the bundle is likely to be less dispersed than their valuations for individual components of the bundle.

Some goods are sold both as a bundle and separately as individual components: the bundle is typically priced at less than the sum of the prices of individual

components. Microsoft Office bundles together software for word processing, spreadsheet analysis, presentation, etc., but it also sells the components programmes separately to individuals who do not value the bundle that much but are willing to pay a lot for specific components. This 'mixed bundling' is more profitable than pure bundling if the costs of producing and distributing the components are not trivial and the heterogeneity in consumers' preferences takes particular forms. The *Oxford Review of Economic Policy* practices mixed bundling, too. You can subscribe to the journal, but you can also buy individual issues at a higher unit price.[11]

Such aggregation may extend in other dimensions. Site licensing of computer software is an alternative to selling it directly to individual users, and as such saves on administration costs and provides greater interoperability to all users at the site. But, as Bakos and Brynjolfsson (2000) point out, this is also a form of aggregation—it aggregates the preferences across different individuals who wish to use the software at the particular site—this typically increases the seller's revenue and enhances welfare. For instance, the value of a site licence to a university is the sum of all individual valuations, so that within the university the software becomes a public good.

In sum, what are the implications of bundling for the manner in which information goods will be sold in online markets? Even though the technology of online transactions makes it relatively cheap to unbundle goods, we should expect product aggregation to survive. Creating a wide range of bundles is relatively cheap for online sellers. Indeed, new forms of mixed bundling may emerge and a wide variety of pricing schemes become the norm. For example, a seller can offer several bundles with different two-part prices. Intensive users might prefer a larger 'entry' fee coupled with low prices for products in the bundle. Occasional users might prefer a lower entry fee and then pay somewhat higher prices for the parts of the (smaller) bundle they use.

### (iii) Welfare

The welfare implications of the greater use of these price strategies in online markets are not straightforward. In general, for many goods sold online, the conventional criterion for welfare maximization, that price equals marginal cost, is unlikely to be satisfied and hence is not a practical benchmark. For instance, for information goods characterized by zero or low marginal costs, versioning allows sellers to recover their fixed costs from customers with high valuations, and also serve consumers with low valuations who would otherwise be priced out of the market. Varian (1985) points out that, in general, if price discrimination enlarges the market, welfare *may* increase. If, on the other hand, it reduces the size of the market, aggregate welfare necessarily decreases. Bundling typically increases social welfare—the sum of retailer profits and consumers' surplus, even though some buyers pay higher prices.

Our discussion is simplistic in that it abstracts from the effects of oligopolistic competition. What effect could competition have on profits, consumer welfare, and aggregate efficiency? Modelling markets in which firms compete by offering different versions and product bundles is notoriously difficult, but Armstrong and Vickers (2001) suggest a novel approach. Since, ultimately, consumers rank bundles by the total amount of utility that each bundle generates, firms can be modelled as competing by directly offering 'utility' to consumers. The welfare effects can then be analysed by looking at the maximum utility that firms can provide subject to breaking even. In strongly competitive markets, firms can attract consumers only by delivering close to this maximum utility. If so, restricting the ways in which a firm can deliver utility, say by prohibiting price discrimination, is likely to reduce this maximum. This may prove to be a useful insight in the welfare analysis of price discrimination on the Internet.

## V. ONLINE AUCTIONS

In many markets, while potential buyers know how much they value a particular good, sellers have a poor idea of these valuations. In such cases an optimal selling procedure should make use of the privately known valuations of buyers in arriving at a price. Imagine that there is only one unit of a good and several prospective buyers. If the seller posted a price that was too high, no one would buy it. On the

[11] For a discussion of alternative forms of pricing for online journals, see Chung-I-Chuang and Sirbu (2000).

other hand, posting too low a price would result in excess demand and loss of potential revenue. In such situations, rather than posting a price, the seller could hold an auction. Auctions allocate objects efficiently—the goods are allocated to those who value them the most—and, in doing so, raise more revenue for the seller than posted prices.

Auctions are hardly a creation of the Internet, but the possibility of cheap and effective communication between market participants has led to their growing use in online markets. A conventional auction has significant transaction costs, as buyers and the seller need to congregate in one place at a particular time (though, sometimes, telephone bids are permitted). Incurring these costs is worthwhile primarily for transactions in high-value items or in wholesale markets for commodities. In contrast, the Internet enables geographically dispersed market participants to find each other, and to communicate asynchronously and cheaply. This has extended the use of auctions to online trade in even relatively low-value items. Many goods that were previously sold in flea markets now appear in online auctions: comic books, concert tickets, collectables such as antiques, stamps, coins, Pokémon cards, and even (as reported by Lucking-Reiley, 2000) a date with 'an attractive woman trying to pay off her credit card debts'! At the same time there has been spectacular growth in business-to-business auctions in commodities and intermediate goods. In the future a substantial fraction of e-commerce may occur through auctions.

Auctions can be organized in different ways.[12] Consider auctions that involve the sale of a single object. In an English auction, also known as an open-cry auction, the price is successively raised until all but one bidder drops out and the winner pays his final bid to secure the good. In a first-price sealed-bid auction, each bidder makes a single, sealed bid: the highest bidder wins and pays his own bid. A second-price sealed-bid auction is similar, except the winner pays only the second highest bid (this is also called a Vickrey auction[13]). In a Dutch auction, the price descends until someone is willing to buy at the current price. Auction theory tells us that, if the bidders' private values for the item on auction are not correlated, all these auction formats raise the same revenue for the seller. In common-value auctions (for instance, when bidding for the right to drill for oil, the value of the prize is the same for all bidders, though their estimates of it may vary), the English auction raises the most revenue, followed by the Vickrey auction, which in turn does better than the first-price sealed-bid and Dutch auctions.[14]

How are online auctions organized? Most single-unit retail auctions on the Internet use some variation of the English auction. Typically, on an online auction site such as eBay, the seller must pay a listing fee for placing an item on auction. In addition to posting a description of the item, the seller also chooses a closing time (typically 3–10 days after the posting date), and possibly a reserve price below which he or she will not sell. Bidders submit their bid electronically and can choose to be informed by e-mail when some other bidder has beaten their bid. They can then respond with higher bids, and so on, as in a conventional auction. Some sites advocate a 'proxy bidding' system, in which each bidder is prompted to reveal his true value to the auction site. The auction site uses this to bid on the buyer's behalf, by submitting bids that beat the current highest bid, but only by the minimum increment required to beat it, till the reported true value is reached. When the auction closes, the highest bidder wins, but only pays a small increment over the second highest bid. Thus, proxy bidding implements a Vickrey auction for private-value auctions. For common-value auctions, proxy bidding is not very useful, and bidding tends to be concentrated towards the end of the auction.

As Lucking-Reiley (2000) shows, the outcome is sensitive to listing fees. Auction sites that charge a high listing fee to sellers make them more intent on selling, inducing them to choose lower reserve prices, and resulting in higher sales as a proportion of listings. For instance, the market leader,

[12] For an excellent review of auction theory, including new developments such as multi-unit auctions, see Klemperer (1999).

[13] For private value auctions, a Vickrey auction is equivalent to an English auction, as the latter ends when the penultimate bidder drops out, so that price has reached the second highest value.

[14] Lucking-Reiley (1999) reports on field experiments to test for revenue equivalence between particular pairs of online auction formats. For an example of online common-value auctions, see Bajari and Hortaçsu (2001), who study online auctions of mint/proof coin sets: these are investment goods rather than mere collectables.

eBay.com, charges significant listing fees and 54 per cent of its auctions result in a sale. In contrast, Yahoo! does not charge a listing fee and only 16 per cent of its auction listings translate into sales.

Many online auctions sell multiple units, rather than a single unit, of a good. Such auctions are harder to analyse. Here bidders must submit demand functions, specifying the number of units they would like to buy at various prices, and all bidders submitting a demand at prices higher than the market-clearing price win. In the discriminatory price variant of multi-unit auctions winners must pay their own bids. In the alternative, uniform price variant, all winners pay only the market-clearing price. OnSale.com uses a trademarked version of discriminatory auctions (called Yankee Auction®) to sell multiple units.

One particular auction-like format combines notions of price discrimination and auctions. Priceline.com asks bidders to 'name their price' for objects such as hotel bookings, airline tickets, and car rental offered by different sellers, and once offers are submitted, sellers decide whether to accept the offers. Such mechanisms enable the seller to carry out price discrimination. Those who buy through conventional channels pay the regular, posted price, while others—who are willing to wait and see if their offer of a lower price is accepted by a seller—typically pay a lower price. To the extent that this allows allocation of some of the excess capacity of sellers, such price discrimination improves social efficiency. There are two alternative ways of organizing such auctions. If all bids are submitted before the sellers decide which to accept, the highest bidders win: this is no different from a standard multi-unit sealed-bid first-price auction. However, suppose buyers arrive randomly (say, by a Poisson process), and the sellers must accept or reject offers sequentially, the auction takes on features of a financial option. An airline seat (say) is very much like a put option that an airline holds, and, for each bid, must decide whether to exercise the option.

Auctions and auction-like trading formats are emerging as important mechanisms in the growing online business-to-business transactions.[15] For instance, MetalSite holds auctions for surplus inventory. Others, such as FreeMarkets Online, hold 'reverse auctions' in which sellers compete by bidding for procurement contracts. The fact that auctions arrive at a price by extracting private information from the bidders is particularly useful in global business transactions, where information is often dispersed and demand is volatile. The mushrooming of online commodity exchanges has seen the emergence of many new 'double auctions'. In such auctions, buyers submit demand functions to the exchange, sellers submit supply functions, and the exchange clears markets and determines prices at each point of time. Theoretical understanding of such new forms, which usually include combinatorial considerations, is in its infancy, and a promising area for future research.

What are the welfare implications of increasing use of online auctions? As noted above, auctions typically allocate objects more efficiently than posted prices. English auctions lead to greater price transparency by revealing prices bid by rival bidders. This leads to information aggregation in common-value settings, and enhances competition. In fact, FreeMarkets Online claims that it makes savings of up to 25 per cent when using an English auction instead of a sealed-bid auction. However, as we noted in section IV, transparency is a double-edged sword. A more transparent pricing structure can just as easily facilitate implicit collusion among bidders. Klemperer (2000) makes an interesting observation. Car sales over the Internet are very much like (reverse) English auctions—each dealer can react to a lower price announced by a rival. The traditional selling method—in which a dealer's bid is not as easily communicated to another—is much more like a sealed-bid first-price auction. As Klemperer explains, the Internet results in more transparent pricing, but this may well increase the likelihood of collusion.

## VI. CONCLUSIONS

The emergence of electronic commerce has altered the nature of competition and pricing in many markets. The entry of online firms has lowered market

[15] See Lucking-Reiley and Spulber (2001) for an overview of business-to-business auctions, and Bichler (2001) for a description of new, often multidimensional, auction-like trading mechanisms.

concentration in some sectors. Quite often, online sellers have a genuine cost advantage over conventional firms. The Internet has also weakened the location-specific market power of sellers, and the availability of search and price-comparison services has increased the intensity of competition in many markets.[16]

Despite their proclaimed cost advantages, many online firms have filed for bankruptcy in the recent past. To some extent this is not hard to understand. While set-up costs are relatively low in online markets, brand names, advertising, and technology come to play an important role. Though there was a rush of new firms in the early years of the Internet, a market structure with many firms may not be quite sustainable in the long run. At low levels of market concentration, each firm has an incentive to escalate its expenditure on advertising and technology to gain market share. Others must either respond, or be forced to exit as consumers are attracted away by high-spending rivals. In such an environment the level of costs rises endogenously and the equilibrium market structure is relatively concentrated, with a handful of firms operating with high fixed costs.[17]

What forms of pricing will prevail in online markets? While the intensity of price competition has increased in some sectors, we believe that this tendency is generally overstated. Online markets are not frictionless: search is far from perfect and, even for homogeneous goods, consumer behaviour is distorted by switching costs and lack of trust in some sellers. Further, sellers may be able to increase product heterogeneity and switching costs through customization. These strategies will result in escalation of fixed costs and in the long run only a few firms will survive in each sector. As the survivors will operate with relatively high fixed costs, competitive pricing will be unable to cover such costs and, hence, be unsustainable.

If the survivors come to acquire some market power, we should expect prevalence of price discrimination. Given that the Internet enables sellers to gather a lot of information on consumers, sellers may be able to personalize prices with greater ease. In general, what happens to prices will depend on the *relative* ability of buyers and sellers to manipulate and use the wealth of information on the Internet. If search engines become more effective, prices may fall. On the other hand, if sellers can identify buyers' preferences, prices may rise, at least for some consumers. Where demand is uncertain, there will be increasing use of auction-like mechanisms. These make use of buyers' valuations in arriving at a price, and enable price discrimination.

What are the welfare implications of these emerging trends? Undeniably, the Internet has made markets more efficient in some senses. Better coordination of supply chains has allowed a reduction in inventory. Low-cost customization of products has increased consumers' utility. Electronic distribution of information goods is an improvement over distributing them on physical media. On the other hand, some of the enhanced expenditure on advertising serves little social purpose and may be welfare reducing. The welfare consequences of the specific pricing strategies are not transparent. We know that price discrimination and the use of auctions may increase welfare even as it increases prices for some consumers, but there may be a case for more careful welfare analysis of emerging pricing strategies. In the past, policy-makers have viewed online markets as relatively contestable and asserted that their growth was a positive development. We believe that there is a case for a careful reassessment of these beliefs.

[16] See Borenstein and Saloner (2001) and Bakos (2001) for a discussion on some sectors where electronic commerce has enhanced competition.

[17] For a careful elaboration of these arguments in the general context of advertising and technology-intensive industries, see Sutton (1991, 1998). For an application to online markets, see Latcovich and Smith in this issue.

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