Online vs. Offline Competition*

Prepared for the *Oxford Handbook of the Digital Economy*

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July 2010

* We thank Martin Peitz and Joel Waldfogel for comments. Syverson thanks the NSF and the Stigler Center and Centel Foundation/Robert P. Reuss Faculty Research Fund at the University of Chicago Booth School of Business for financial support.

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1. Introduction

Amazon.com is arguably one of the most successful online firms. As of this writing, its market value is over $52 billion, equal to the combined value of two large and successful offline retailers, Target and Kohl's, who have 2800 stores between them.

Jeff Bezos conceived of Amazon.com as a business model with many potential advantages relative to a physical operation. It held out the potential of lower inventory and distribution costs and reduced overhead. Consumers could find the books (and later, other products) they were looking for more easily, and a broader variety could be offered for sale in the first place. It could accept and fulfill orders from almost any domestic location with equal ease. And most purchases made on its site would be exempt from sales tax.

On the other hand, Bezos no doubt understood some limitations of online operations. Customers would have to wait for their orders to be received, processed, and shipped. Because they couldn't physically inspect a product before ordering, Amazon.com would have to make its returns and redress processes transparent and reliable, and offer other ways for consumers to learn as much about the product as possible before buying.

Amazon's entry into the bookselling market posed strategic questions for brick-and-mortar sellers like Barnes & Noble. How should they respond to this new online channel? Should they change prices, product offerings, or capacity? Should they start their own online operation—and if they did so, how much would this cannibalize their offline sales? How closely would their customers see ordering from the upstart in Seattle as a substitute for visiting their stores?[1]

The choices made by these firms and consumers' responses to them—both of which were driven by the changes in market fundamentals wrought by the advent and diffusion of e-commerce technologies in bookselling—changed the structure of the market. As we now know, Amazon is the largest single bookseller (and sells many other products). Barnes & Noble, while still large, has seen its market share diminish markedly. There are also many fewer bricks-and-mortar specialty bookshops in the industry. Prices are lower.

In this chapter, we will review multiple aspects of competition between the online and offline segments of a market. We will take a broad view rather than focus on a specific case

[1] Ghemawat and Baird (2004, 2006) offer a detailed exploration of the nature of competition between Amazon and Barnes & Noble.

study, but many of the elements that drove the evolution of the retail bookselling market as we just described will be addressed more generally.

We organize our discussion as follows. The next section lays out some basic facts about the online sales channel: its size relative to offline sales; its growth rate; and the heterogeneity in online sales intensity across different sectors, industries, and firms; and the characteristics of consumers who buy online. Section 3 discusses the ways that markets' online channels are economically different in terms of e-commerce's effects on market demand and supply fundamentals. Section 4 explores how these changes in fundamentals brought about by the introduction of an online sales channel might be expected to change equilibrium market outcomes. Section 5 investigates various strategic implications of dual-channeled markets for firms. A short concluding section follows.

2. Some Facts

Before discussing the interplay of online and offline markets, we lay out some basic empirical facts to show the current status of online and offline competition.

2.1. How Large Are Online Sales Relative to Offline Sales?

To take the broadest possible look at the data, it is useful to start with the e-commerce information collected by the U.S. Census Bureau, which compiles some of the most comprehensive data on e-commerce activity available.[2] The Census separately tracks online- and offline-related sales activity in four major sectors: manufacturing, wholesale, retail, and a select set of services. The data are summarized in Table 1. In 2008, total e-commerce-related sales in these sectors were $3.7 trillion. Offline sales were $18.7 trillion. Therefore transactions using some sort of online channel accounted for just over 16 percent of all sales. Not surprisingly, the online channel is growing faster. Nominal e-commerce sales grew by over 120 percent between 2002 and 2008, while nominal offline sales grew by only 30 percent. As a greater fraction of the population goes online—and uses the internet more intensively while doing so—e-commerce's share will almost surely rise.

[2] The Census Bureau defines e-commerce as "any transaction completed over a computer-mediated network that involves the transfer of ownership or rights to use goods or services." In this definition, a "network" can include open networks like the internet or proprietary networks that facilitate data exchange among firms. For a review of how the Census Bureau collects data on e-commerce and the challenges posed in quantifying e-commerce, see Mesenbourg (2001).

The relative contribution of online-based sales activity varies considerably across sectors, however. Looking again at 2008, e-commerce accounted for 39 percent of sales in the manufacturing sector and 21 percent in wholesale trade, but only 3.6 percent in retail and 2.1 percent in services. If we make a simple but broadly accurate classification of deeming manufacturing and wholesale sales as business-to-business (B2B), and retail and services as business-to-consumer (B2C), online sales are considerably more salient in relative terms in B2B sales than in B2C markets. Because total B2B and B2C sales (thus classified) are roughly equal in size, the vast majority of online sales, 92 percent, are B2B related.[3] That said, B2C e-commerce is growing faster: it rose by 174 percent in nominal terms between 2002 and 2008, compared to the 118 percent growth seen in B2B sectors. In terms of shares, e-commerce-related B2B sales grew by about half (from 19 to 29 percent) from 2002 to 2008, while more than doubling (from 1.3 to 2.7 percent) in B2C sectors over the same period.[4]

When considering the predominance of B2B e-commerce, it is helpful to keep in mind that the data classify as e-commerce activity not just transactions conducted over open markets like the internet, but also sales mediated via proprietary networks as well. Within many B2B sectors, the use of Electronic Data Interchange as a means of conducting business was already common before the burgeoning use of the internet as a sales channel during the mid 1990s. While some research has looked at the use of less open networks (e.g. Mukhopadhyay, Kekre, and Kalathur, 1995), the academic literature has focused on open-network commerce much more extensively. We believe that much of the economics of the more B2C-oriented literature discussed in this paper applies equally or nearly as well to B2B settings. Still, it is useful to keep the somewhat distinct focal points of the data and the literature in mind.

2.2. Who Sells Online?

[3] The Census Bureau defines the B2B and B2C distinction similarly to the sector-level definition here. It is worth noting, however, that because the Bureau does not generally collect transaction-level information on the identity of the purchaser, these classifications are only approximate. Also, the wholesale sector includes establishments that the Census classifies as manufacturing sales branches and offices. These are locations separate from production facilities through which manufacturers sell their products directly rather than through independent wholesalers.

[4] The Census Bureau tracks retail trade e-commerce numbers at a higher frequency. As of this writing, the latest data available are for the first quarter of 2010, when e-commerce-related sales accounted for a seasonally-adjusted 4.0 percent of total retail sales.

In addition to the variation in online sales intensity across broad sectors that we just discussed, there is also considerable heterogeneity within sectors. Within the NAICS manufacturing industry, the share of online-related sales ranges from 21 percent in Leather and Allied Products to 54 percent in Transportation Equipment. In retail, less than one third of one percent of sales at Food and Beverage stores are online; on the other hand, in the Electronic Shopping and Mail-Order Houses industry (separately classified in the NAICS taxonomy as a 4-digit industry), online sales account for 47 percent of all sales. Similar diversity holds across industries in the wholesale and service sectors.

Differences in the relative size of online sales across more narrowly defined industries can arise from multiple sources. Certain personal and business services (e.g. plumbing, dentistry, copier machine repair) are inherently unsuited for online sales, though obviously certain logistical aspects of these businesses, such as advertising and billing, can be partially conducted online. Likewise, consumer goods that are typically consumed immediately after production or otherwise difficult to deliver with a delay (e.g., food at restaurants or gasoline) are also rarely sold online.

We consider a number of variables that one might think can explain the heterogeneity in the online channel's share of sales across manufacturing industries: the dollar value per ton of weight of the industry's output (a measure of the transportability of the product; we use its logarithm), R&D expenditures as a fraction of sales (a proxy for how "high-tech" the industry is), logged total industry sales (to capture industry size), and an index of physical product differentiation within the industry. We construct these measures by 3-digit NAICS industry for industries in the manufacturing sector and compare them to the online channel's share of industry sales.[5]

Raw pairwise correlations between the fraction of commerce within an industry that is due to e-commerce and the four factors we just outlined do not reveal strong patterns. If we instead regress all four factors on the e-commerce fraction, we find that the only significant predictor is the log of industry size. Though our small sample size makes inference difficult, the

[5] The R&D data is aggregated across some of the 3-digit industries, so when comparing online sales shares to R&D, we aggregate the sales channel data to this level as well. This leaves us 17 industries to compare. Additionally, the product differentiation index (taken from Gollop and Monahan 1991) is compiled using the older SIC system, so we can only match 14 industries in this case.

results do not indicate a strong role for these factors in explaining the heterogeneity in importance of e-commerce across manufacturing industries.

Looking at differences in online sales activity across firms, Forman et al. (2003) study investment by commercial firms in e-commerce capabilities. The authors use the Harte Hanks Market Intelligence CI Technology database from June 1998 through December of 2000. It includes information on technology use for over 300,000 establishments. The survey has content in three areas: characteristics of each establishment (e.g. industry, location, number of employees), the establishment's use of hardware and software, and use of internet applications and networking services.

With this data, the authors classify investments in e-commerce capabilities into two categories: participation and enhancement. The former includes developing basic communications capabilities like supporting email, having an active website, and allowing passive document sharing. Enhancement involves adopting technologies that alter internal operations or lead to new services. Participation rates, as they define it, are high: around 90 percent in most industries, though somewhat lower in others. Enhancement investment rates were lower, of course, but they were considerably so. Only 12 percent of firms had adopted internet technologies that fell into the enhancement category. The two-digit NAICS industry with the highest adoption rate (28 percent) was Management of Companies and Enterprises (NAICS 55). The lowest adoption rate (6.2 percent) was seen in Educational Services (NAICS 61). So while most firms did adopt some internet technologies, only a fraction adopted technologies that fundamentally changed their business.

2.3. Who Buys Online?

We can use data from the 2005 Forrester Research Technographics survey to form an image of what online shoppers look like. The Technographics survey is a representative survey of North Americans that asks a number of questions about respondents' attitudes toward and use of technology.

We first look at who uses the internet in any regular capacity (not necessarily for online shopping) by running a probit regression of an indicator for whether the respondent uses the internet on a number of demographic variables. The estimated marginal effects are in Table 2,

column 1. By the time of the survey, more than 75 percent of the sample reported being online, so the results do not reflect the attributes of a small number of technologically savvy early adopters.

Internet users are higher-income, more educated, and younger. The coefficients on the indicators for the survey's household income categories imply that having annual income below $20,000 is associated with a 22 percentage point smaller probability of being online than being in a household with an income over $125,000, the excluded group in the regression. Internet use increases monotonically with income until the $70,000-90,000 range. Additional income seems to have little role in explaining internet use after that threshold.

The results indicate that education is also a sizeable determinant of who is online, even controlling for income. Relative to having a high school degree (the excluded category), not having graduated from high school reduces the probability of using the internet by 8 to 9 percentage points (we include categorical variables for the education of both the female and male household heads), while having a college degree raises it by 6 to 8 points.

Not surprisingly, the propensity to be online declines with age. The coefficient on the square of age is negative and significant; hence the magnitude of the marginal effect grows slightly with age. For example, a 35-year-old is 5.5 percentage points less likely to be online than a 25-year-old, while a 60-year-old is 6.8 percentage points less likely than a 50-year-old to use the internet.

Race also explains some variation in internet use controlling for these other factors, though the size of the marginal effect is modest. Blacks are about 4 percentage point less likely to be online than Whites, while Asians are 3 percentage points more likely. Hispanics are online at the same rate as whites.

Gender does not seem to be a factor in explaining online behavior.

The results in column 2 of Table 2 look at online purchasing behavior per se. The column shows the marginal effects of a probit regression on whether the survey respondent reported making an online purchase within the last year. The qualitative patterns estimated are quite similar to those for the probit on internet use, though the magnitudes of many of the marginal effects are larger. So while a low income person (household income less than $20,000 per year) is about 22 percentage points less likely to be online than someone from a household making $125,000 or more, they are 31 percentage points less likely to actually buy something

online. Similarly, not having a high school diploma reduces the probability of online purchases by 11 to 13 percentage points relative to having a diploma (as opposed to 8 to 9 percentage point effects on internet use), and having a college degree now raises it by 8 to 11 percentage points (it is 6 to 8 points for use). Age effects are also larger, now being in the 8 to 13 percentage point range per 10 years, depending on the ages being compared (the magnitude of the age effect is still convex). In terms of race, there is an interesting differential in the size of the gap between Blacks and other races. Whereas blacks were 4 percentage points less likely to be online, they are about 11 percentage points less likely to make purchases once online. On the other hand, while Asians were more likely to be online than Whites and Hispanics, they are not significantly more likely to report having bought goods or services online.

Though not shown, we also ran regressions conditional on internet use. The results are very similar to the coefficients from the second column. This indicates that selection on who uses the internet is not driving the patterns of who purchases products online.

These patterns are informative and largely in line with what we suspect are many readers' priors. But they reflect overall online purchasing likelihoods, not the determinants of whether consumers, when buying *a particular product*, choose to do so via online or offline channels. However, the Technographics survey collects additional information on the method of purchase for specific types of products. We can make such comparisons in this case.

We show consumers' responses regarding a set of financial products: auto loans, credit cards, mortgages and home equity loans, auto and life insurance, and checking accounts. The survey asks both whether each of these products were researched online or offline prior to purchase, and whether any purchase was made online or offline. Table 3 reports the results.

Column 1 of Table 3 simply reprints for the sake of comparison the results from column 2 of Table 3, on whether the respondent made any purchase online within the past 12 months. Column 2 of Table 3 reports analogous results for a probit on whether the respondent bought any of the particular financial products listed above online within the past year. Many of the qualitative patterns seen for online purchases in general are observed for financial products in particular, but there are some interesting differences. The effect of age is still negative, but is now concave in magnitude rather than convex. And while having a college degree is associated with a significantly higher probability of buying *something* online, it has a much smaller and insignificant (and in the case of the female head of household, negative) role in financial

products. Most striking are the results on race. Blacks are 11 percentage points less likely to purchase products online than Whites. But for financial products, they are 1.5 percentage points *more* likely to buy online. Not only is this effect in the opposite direction of the overall results, it is almost as large in magnitude in relative terms.[6] Asian and Hispanic are similarly more likely (economically and statistically) to buy financial products online than Whites, while they did not exhibit statistically significant purchase patterns for overall online purchases. We speculate this differential racial pattern for financial products may reflect minorities' concerns about discrimination in financial product markets, but in the absence of additional evidence, we cannot really know.

Finally, we look at changes in consumers' propensity to buy specific products online in Table 4. The second column of the table lists, for a number of product categories that we can follow in the Forrester Technographics survey over 2002 to 2007, the five-year growth rate in consumers' reported frequency of buying the product online. For reference, the fraction of consumers reporting having bought the product online in the past year is shown in the third column. The fastest online growth was seen in the purchase of auto insurance policies, one of the financial products we just discussed. Consumers' likelihood of buying this insurance online nearly tripled between 2002 and 2007, though from an initially small level; in 2007, 7.6 percent of survey respondents reported having bought auto insurance online in the previous year. Many of the "traditional" online products (if there is such a thing after only about 15 years of existence of e-commerce)—books, computer hardware, airline tickets, and so on—saw more modest but still substantial growth.[7] However, while the growth rate of online purchases for a product is negatively correlated with its 2002 level, the correlation is modest ($\rho = -0.13$) and not significantly different from zero. Hence it's not simply the case that the fastest growing products were those that had the slowest start.

[6] Note that when comparing the magnitudes of the coefficient estimates across columns in Table 2, one should be mindful of the average probability of purchase in the entire sample, p_{bar}, which is displayed at the bottom of the table. Because the average probability of purchasing one of the financial products online (9.6 percent) is roughly one-fifth the probability that any product is purchased (50.9 percent), the estimated marginal effects in the financial products' case are five times the relative size. Thus the 1.5-percentage-point marginal effect for Black respondents and financial products in column 2 corresponds to a roughly 7.5-percentage-point marginal effect in column 1.

[7] Two products saw substantial declines in online purchase likelihoods: mortgages and small appliances. The former is almost surely driven by the decline in demand for mortgages through any channel. We are at a loss to explain the decline in small appliance purchases.

3. How Is the Online Channel Different from the Offline Channel?

E-commerce technology can affect both the demand and supply fundamentals of markets. On the demand side, e-commerce precludes potential customers from inspecting goods prior to purchase. Further, online sellers tend to be newer firms and therefore may have less brand or reputation capital to signal and/or bond quality. These factors can lead to information asymmetries between buyers and sellers absent from offline purchases. Online sales also involve a delay in consumption when a product must be physically delivered. At the same time, however, e-commerce technologies reduce consumer search costs, making it easier to (virtually) compare different producers' products and prices. On the supply side, e-commerce enables new distribution technologies that can reduce costs along the supply chain, improve service, or both. Both the reduction in consumer search costs and the new distribution technologies combine to change the geography of markets; space can matter less online. Finally, and further combining both sides of the market, online sales face different tax treatment than offline sales. We discuss each of these factors in turn in this section.

3.1. Asymmetric Information

Information asymmetries are larger when purchasing online for a few reasons. The most obvious is that the consumer does not have the opportunity to physically examine the good at the point of purchase. This presents a potential lemons problem where unobservably inferior varieties are selected into the market. Another is that because online retailing is relatively new, retailers have less brand capital than established traditional retailers. A related factor is some consumers' concerns about the security of online transactions.

Because information asymmetries can lead to market inefficiencies, both buyers and sellers (and particularly those sellers of high-quality goods) have the incentive to structure transactions and form market institutions that alleviate lemons-type problems. Many examples of such efforts on the part of online sellers exist. Firms such as Zappos.com offer free shipping on purchases and returns, making it easier for consumers to in effect make purchase conditional upon an inspection. However, there is a delay between the decision to order and the ability to consume a good that is inherent to online commerce but largely absent in traditional offline channels.

An alternative approach is to try to convey prior to purchase the information that would be gleaned by inspecting the product. Garicano and Kaplan (2001) examine used cars sold via an online auction, Autodaq, and physical auctions. They find little evidence of adverse selection or other informational asymmetries. They attribute this to actions that Autodaq has taken in order to reduce information asymmetries. Besides offering extensive information on each car's attributes and condition, something that the tools of e-commerce actually make easier, Autodaq will broker arrangements between potential buyers and third-party inspection services. Jin and Kato (2007) examine the market for collectable baseball cards and describe how the use of third-party certification has alleviated information asymmetries. They find a large increase in the use of professional grading services when eBay came online and began being used for buying and selling baseball cards. Another form of disclosure is highlighted in Lewis (2009). Using data from eBay Motors, he finds a positive correlation between the number of pictures that the seller posts and the winning price of the auction. However, he does not find evidence that information voluntarily disclosed by the seller affects the probability that the auction listing results in a sale.

Instead of telling consumers about the product itself, firms can try to establish a reputation for quality or some other brand capital. Smith and Brynjolfsson (2001) use data from an online shopbot to study the behavior of online book consumers. They find that brand has a significant effect on the consumers' willingness to pay. Consumers are willing to pay an extra $1.72 (the typical item price in the sample is about $50) to purchase from one of the big three online book retailers: Amazon, Barnes & Noble, or Borders. There is evidence that the premium is due to perceived reliability of the quality of bundled services, and shipping times in particular. In online auction markets, rating systems provide a mechanism for even small sellers to build reputations, although Bajari and Hortaçsu (2004) review the empirical research evaluating the premium accruing to sellers with high feedback ratings and conclude that the evidence on whole is ambiguous. Perhaps a cleaner metric of the effect of reputation in such markets comes from the field experiment conducted by Resnick et al. (2006). There, an experienced eBay seller with a very good feedback rating sold matched lots of postcards. A randomized subset of the lots was sold by the experienced eBay seller, using its own identity. The other subset part was sold by the same seller, but using a new eBay seller identity without any buyer feedback history. The lots sold using the experienced eBay seller identity received winning bids that were approximately eight percent higher. In a more recent paper, Adams, Hosken, and Newberry (2009) evaluate

whether seller ratings affect the price that people are willing to pay for Corvettes on eBay Motors. Most of the previous research had dealt with items of small value where the role of reputation might have a relatively modest influence. Collectable sports cars, however, are clearly high value items. In that market, Adams et al. find very little effect (even negative) of seller ratings.

Another recent paper, Cabral and Hortaçsu (2010), takes a different approach to estimating the effects of eBay's seller reputation mechanism. They first run cross-sectional regressions of prices on seller ratings and obtain results similar to Resnick et al. (2006). Then they use a panel of sellers and examine how reputation affects outcomes over time. They find that when a seller receives her first negative feedback, her sales growth rate falls from a positive 5% to a negative 8%, subsequent negative feedback arrives more quickly, and that as the seller's rating falls, she becomes more likely to exit. Their evidence suggests an important role for eBay's seller reputation mechanism.

Outside of online auction markets, Waldfogel and Chen (2006) study the interaction of branding online and information about the company from a third party. In their study, they find that the rise of information intermediaries such as BizRate leads to lower market shares for major branded online sellers such as Amazon.com. So while firms may use branding to reduce consumers' concerns about online transactions, other sources of information may be able to overcome some of the information asymmetries and lead to a reduced need for branding.

3.2. Delay between Purchase and Consumption

While a lot of digital media that is purchased online can be used/consumed almost immediately after purchase (assuming download times are not a factor), online purchases of physical goods typically involve a delivery lag that can range from hours to days and, occasionally, weeks. Furthermore, these delayed-consumption items are the kind of product most likely to have coexisting online and offline outlets, so this lag can be particularly salient when considering the interaction between a market's online and offline channels.

The traditional view of a delay between choice and consumption is as a waiting cost. This may be modeled as a simple discounted future utility flow or as a discrete cost (e.g., Loginova 2009). However, more behavioral explanations hold out the possibility that, for some goods at least, the delay actually confers benefits to the purchaser in the form of anticipating a pleasant consumption experience (e.g., Loewenstein 1987). Thus the implications of delay on

the effect on markets when online channels are introduced may be ambiguous. Though again, if delay confers a consistent competitive advantage, it seems that offline sellers could offer their consumers the option to delay consumption after purchase rather easily.

3.3. Reduced Consumer Search Costs

It is generally accepted that search costs online are lower than in offline markets. While sequentially searching individual stores online is very similar to simply calling bricks-and-mortar stores, the gains are due to the aggregation of consumer information in a single location. The rise of consumer information sites, from price-comparing shopbots to product review and discussion forums, has led to a large decrease in the costs to consumers of gathering information. This has important implications for market outcomes like prices, market shares, and profitability, as will be discussed in detail in Section 4.

Online search isn't completely free; several papers have estimated positive but modest costs. Bajari and Hortaçsu (2003), for example, find the implied price of entering an eBay auction to be $3.20. Brynjolfsson, Dick, and Smith (2010) estimate that the maximum cost of viewing additional pages of search results on a books shopbot is $6.45. Hong and Shum (2006) estimate the median consumer search cost for textbooks to be less than $3.00. Nevertheless, while positive, these costs are less for most consumers than the value of the time it would take them to travel to just one offline seller.

3.4. Lower Distribution Costs

E-commerce has affected how goods get from producers to consumers. In some industries, the internet has caused disintermediation—diminishing the roles of, or in some cases entirely removing, links of the supply chain. For example, the number of travel agency offices fell by 47 percent, from approximately 29,500 to 15,700, in the 10 years between 1997 in 2007. This was accompanied by a large increase in consumers' propensity to make travel arrangements—and buy airline tickets in particular—directly, using online technologies.[8]

[8] An interesting case where the internet brought about *increased* intermediation is in auto sales. There, at least in the U.S., legal restrictions require all sales to be through a physical dealer (who in turn cannot be owned by a manufacturer). Give this restriction, online technologies in this industry were devoted to creating referral services like Autobytel.com. Consumers shop for and select their desired vehicle on the referral service's website, and then the service finds a dealer with that car and has the dealer contact the consumer with a price quote (Saloner and Spence 2002).

E-commerce technologies have also brought changes in how sellers fulfill orders. Firms can quickly assess the state of demand for their products and turn this information into orders sent to an upstream wholesaler or manufacturer. This has reduced the need for inventory holding. For example, retail inventory-to-sales ratios have dropped from around 1.65 in 1992 to 1.35 in early 2010, and from 1.55 to 1.25 over the same period for "total business," a sum of the manufacturing, wholesale, and retail sectors.[9]

An example of how increased speed of communication along the supply chain affects distribution costs is a practice referred to as "drop-shipping." In drop-shipping, retailers transfer orders to wholesalers, who then ship directly to the consumer, bypassing the need for a retailer to physically handle the goods and reducing distribution costs. Online-only retailers in particular can have a minimal physical footprint when using drop-shipping; they only need a virtual storefront to inform customers and take orders.[10]

Randall, Netessine, and Rudi (2006) study the determinants of supply chain choice. Markets where retailers are more likely to adopt drop-shipping have greater product variety, higher ratio of retailers to wholesalers, and products that are large or heavy relative to their value. Product variety creates a motive for drop-shipping because unexpected idiosyncracies in variety-specific demand make it costly to maintain the correct inventory mix at the retail level. It is easier to allow a wholesaler with a larger inventory to assume and diversify over some of this inventory risk.[11] Similar reasoning shows that drop-shipping is more advantageous when there is a high retailer to wholesaler ratio. Relatively large or heavy products are more likely to be drop-shipped: physically distributing such goods is more expensive and skipping an extra step of shipping along the supply chain (from wholesaler to retailer) can save substantial costs.

The internet has also affected the catalog of products available to consumers. Bricks-and-mortar operations are limited in the number of varieties they offer for sale at one time, because margins from very-low-volume varieties cannot cover the fixed costs of storing them

[9] http://www.census.gov/mtis/www/data/text/mtis-ratios.txt, retrieved 7/9/10.

[10] The practice has been adopted by many but not all online-only retailers. Netessine and Rudi (2006) report recent survey results indicating that 31 percent of pure-play internet retailers use drop-shipping as their primary method of filling orders.

[11] Traditional retailers have used other mechanisms to serve a similar function (though likely at a higher cost). For example, retailers with multiple stores will often geographically pool inventory risk by cross-shipping orders from a store that has an item in inventory to one that takes a customer order but is stocked out (e.g., Krishnan and Rao 1965).

before sale. Online sellers, however, can aggregate demand for these low-volume varieties over a larger geographic market (this will be discussed in section 3.5 below). At the same time, they typically have a lower fixed cost structure. As a result of these combined technological changes, they can offer a greater variety of products for sale. (Additionally, e-commerce's consumer search tools can make it easier for consumers of niche products to find sellers.) This "long-tail" phenomenon has been studied by Brynjolfsson, Hu, and Smith (2003) and others. Brynjolfsson et al. find that the online book retailers offer 23 times as many titles as did a typical bricks-and-mortar Barnes & Noble. They estimate that this greater product variety generates consumer welfare gains that are 7 to 10 times larger than the gains from increased competition.

3.5. The Geography of Markets

E-commerce allows buyers to browse across potential online sellers more easily than is possible across offline outlets. This fading of markets' geographic boundaries is tied to the reduction in search costs in online channels. Further, e-commerce technologies can often reduce the costs of distributing products across wide geographies. The practice of drop-shipping discussed above is an example; eliminating the need to ship to retailers can make it easier for supply chains to service greater geographic markets.

There is some empirical support for this "death of distance" notion (Cairncross, 1997). Kolko (2000) finds that cities that are farther away from other cities are more likely to make use of the internet; Forman, Goldfarb, and Greenstein (2005) find that rural areas are on the margin more likely to adopt participation technologies, as defined above, that aid communication across establishments; and Sinai and Waldfogel (2004) find that conditional on the amount of local content on the internet, people in smaller cities are more likely to connect to the internet than people in larger cities.

Yet despite this, several studies suggest spatial factors still matter. Hortaçsu et al (2009) look at data from two internet auction websites, eBay and MercadoLibre. They find that the volume of exchanges decreases with distance. In particular, buyers and sellers that live in the same city have considerable preferences for trading with one another rather than someone outside the metropolitan area. They surmise that cultural factors and the easier ability to directly enforce contracts, should a breach occur, explain this result. Blum and Goldfarb (2006) find that geography matters online even for some purely digital goods like downloadable music, pictures,

and movies, where transport and other possible trade costs are nil. They attribute this to culturally correlated tastes among producers and consumers that live in relative proximity. Sinai and Waldfogel (2004) find evidence of broader complementarities between the internet and cities. Using Media Metrix and Current Population Survey data, they show that larger cities have substantially more local content online than smaller cities and that this content leads people to connect to the internet.[12]

We can test whether geography matters online more generally. We compare the locations of pure-play online retailers to the locations of people who purchase products online. If e-commerce makes geography irrelevant, we would expect the two to be uncorrelated. On the other hand, if online sellers are physically located near customers, this suggests that geography still plays a role in these markets. Unfortunately, we cannot distinguish with such data whether the relevant channel is shipping costs, contract enforceability, or something else.

We measure the number of online-only businesses in geographic markets using County Business Patterns data on the number of establishments in NAICS industry 45411, "electronic shopping and mail-order houses." This industry classification excludes retailers that have any physical presence, even if they are a hybrid operation with some online component. Hence these businesses are exclusively selling at a distance. (Though they may not necessarily be online, as they could be exclusively a mail order operation. We will consider the implications of this below.) We use the responses to the Technographics survey discussed above to construct a measure of the extent people living in a geographic area purchase products online. Specifically, we compute the fraction of respondents living in a geographic market that report having made at least one online purchase in the previous year. We use the Component Economic Areas (CEAs) constructed by the U.S. Bureau of Economic Analysis as our geographic market definition. CEAs are groups of economically connected counties; in many cases, this means they are an MSA plus some additional outlying counties. There are approximately 350 CEAs in the U.S. Goldmanis et al. (2010) use the same variable to measure the intensity of local online shopping. We have an annual panel of observations of market-level NAICS 45411 establishments and online shopping intensity for 1998-2007.

[12] As noted above, the same authors find that conditional on local content, people from smaller cities are more likely to connect to the internet. Interestingly, in their data, these two forces just offset so that use of the internet isn't strongly correlated with city size.

Table 5 shows the results from regressing the number of pure-play online sellers on the fraction of consumers in the local market that purchase products online. We include CEA fixed effects in the regression because unobserved factors might cause certain markets to be amenable to both online sellers and online buyers. For example, Silicon Valley' human capital is desired by online retailers while at the same time makes Valley consumers apt to shop online. The market fixed effects remove the influence of permanent differences in online supply and demand across markets.[13] We also include logged total employment in the CEA in the regression, to control for overall economic growth in the market, and year fixed effects to remove aggregate trends.

The estimate in column 1 of Table 5 indicates that as the fraction of consumers purchasing products online in a market increases by ten percentage points, on average another 2.2 electronic shopping and mail-order businesses open in the local area. While NAICS 45411 can include mail-order businesses that are not selling online, it is seems likely that growth in mail-order operations within a market would either be uncorrelated or even negatively correlated with the growth of online shopping in the market. Hence it is likely the estimated coefficient reflects growth in the number of pure-play online retailers in response to greater use of e-commerce by local consumers.

Columns 2 through 7 of Table 5 report results from similar regressions that use counts of NAICS 45411 establishments in various size categories as the dependent variable. It is clear that a given increase in online shopping is tied to a larger increase in the number of smaller establishments than larger ones. If we instead use the natural log of the number of establishments as the dependent variable, the estimated effects are much more uniform across the size distribution of firms. So in percentage terms, increasing the fraction of consumers who shop online in an area increases the number of firms, regardless of size. This suggests that in addition to pulling small, marginal firms into the market, existing firms might increase in size as well.

3.6. Tax Treatment

[13] We have also estimated specifications that control for the fraction of the local population that uses the internet for any purpose. (This variable is similarly constructed from the Technographics survey, using the question mentioned in the previous section on general internet use.) This did not substantively impact the nature of the results described below, except to make the estimated positive effect of online shopping on online retailers larger.

One advantage that many online transactions enjoy over transactions in a physical store is the absence of sales tax. Legally, U.S. citizens are obligated to pay their state sales or use taxes based on their online purchases. This rarely happens in practice, as reporting and payment is left completely to the consumer. Only when the online seller "has nexus" in the consumer's state is the sales tax automatically added to the transaction price by the firm.[14] This unevenness of the application of sales taxes could lead to a strong advantage for online retail purchases. For example, consumers in Chicago buying online at the end of 2009 would avoid the applicable sales tax of 10.25 percent, a considerable savings.

Goolsbee (2000) provides the first empirical evidence on this subject. Using the Forrester Research Technographics survey, he estimates the elasticity of the probability of consumers buying products on the internet with respect to the local tax rate to be approximately 3.5. This estimate implies substantial sensitivity of online purchases to tax treatment: if the average sales tax in his data (6.6 percent) were applied to all online transactions, the number of people purchasing products online would fall by 24 percent.

While Goolsbee (2000) estimates the effect of sales tax on the extensive margin (whether a person buys anything online), Ellison and Ellison (2009b) estimate the effect of taxes on a measure of total sales that includes both the extensive and intensive margins. Their findings are similar to Goolsbee's, further bolstering the case that applying sales taxes to internet purchases could reduce online retail sales by one-quarter.

On the firm side, the tax structure can distort firm location decisions. Suppose a firm's base of operations is in Delaware to take advantage of the state's lax tax laws. If the firm were to create a distribution center in the Midwest to decrease the time it takes to fulfill orders from the Midwest, then it might choose to open the distribution center in the state with relatively few purchasers. A case study of Barnes & Noble (Ghemawat and Baird, 2004) illustrates this point nicely. When Barnes & Noble first created an online business, the online division was almost entirely separate from the brick-and-mortar store. The one shared resource among the online and offline divisions was the company's book buyers. Even though the two divisions shared buyers,

[14] The great majority of states have a sales tax; only Alaska, Delaware, Montana, New Hampshire, and Oregon do not. For the seller to be bound to apply sales tax to a transaction, the consumer must be in a location in which the seller has nexus. Whether a firm has nexus within a state is not always obvious. In the Supreme Court decision *Quill vs. North Dakota* (1992), it was established that online merchants without a substantial physical presence in the state would not have to enforce sales tax in that state. Later, the 1998 Internet Tax Nondiscrimination Act clarifies that a web presence in a state does not constitute nexus.

the books to be sold by BarnesandNoble.com were separated and traveled exclusively to a distribution center in Jamesburg, New Jersey. Books to be sold in the traditional brick-and-mortar stores were sent to different facilities to make it clear which books would not be subject to sales tax.

The desire to circumvent sales tax affected other competitive decisions that Barnes & Noble made. BarnesandNoble.com went online in May of 1997. They initially refused to install kiosks in stores used to order products online. They also avoided delivering books ordered online to their physical stores to be picked up by customers. It wasn't until October 2000 that Barnes & Noble, after not significantly competing with Amazon.com, decided to forego the sales tax benefits it had enjoyed and integrate its online and offline businesses (Ghemawat and Baird, 2006).

4. How E-commerce Affects Market Outcomes

The changes in demand- and supply-side fundamentals that e-commerce brings can foment substantial shifts in market outcomes from their offline-only equilibrium. These include prices, market shares, profitability, and the type of firms operating in the market.

4.1. Prices

Perhaps no market outcome has been studied more intensively in the context of online sales activity than prices. Much of the conventional wisdom and some theoretical work (e.g., Bakos (1997) and Goldmanis et. al (2010)) has focused on the potential for e-commerce to reduce prices. Both reduced consumer search costs and lower distribution costs—two of the fundamental mechanisms described in the previous section—can act to reduce prices in online markets. Lower search costs make firms' residual demand curves more elastic, reducing their profit-maximizing prices. Reduced distribution costs directly impact profit-maximizing prices if they reflect changes in marginal (rather than fixed) costs.[15]

A body of empirical work has supported these predictions about lower prices. For example, Brynjolfsson and Smith (2000) and Clay, Krishnan, and Wolff (2001) find that prices drop due to the introduction of online book markets. Scott Morton, Zettelmeyer, and Silva-Risso

[15] Asymmetric information can affect prices as well, though the direction of this effect is ambiguous. Quantities, however, should decline if information becomes more asymmetric.

(2001) document that consumers who used an online service to help them search for and purchase a car paid on average two percent less than other consumers. Brown and Goolsbee (2004) find that price comparison websites led prices for term life insurance policies to fall by 8-15 percent. Sengupta and Wiggins (2006) document price reductions in airline tickets driven by online sales.

Many of the price reductions documented in these studies and others result from e-commerce technologies making markets more competitive, in the sense that firms' cross-price elasticities rise. We will discuss below how this can be beneficial for firms that have relative cost advantages over their competitors. However, these same competitive forces can also give strong incentives to firms *without* cost advantages to limit the impact of price differentials. These firms would like to take actions that reduce the propensity of consumers—who now have enhanced abilities to compare their options among sellers—to shift their purchases toward lower-cost sellers, thereby supporting the price-cost margins necessary to cover the higher-cost firms' fixed costs.

Certainly, *some* such barriers to substitution exist online. E-commerce markets are not the utterly frictionless commodity-type markets sometimes speculated about early in the internet's commercial life. Often, more than just the product upon which the transaction is centered is being sold. Goods are usually bundled with ancillary services, and the provision of these services might vary across sellers without being explicitly priced. Sellers' brands and reputations might serve as a proxy or signal for the quality of such service provision. Smith and Brynjolfsson (2001) quantify an example of such effects in online book sales. Heavily branded online booksellers like Amazon, Barnes and Noble, and Borders earn an average price premium of around 3.5 percent over their more generic competitors for the same book, presumably reflecting consumers' willingness to pay for ancillary services like faster or more reliable delivery. Waldfogel and Chen (2006), while finding price comparison websites weaken brand effects, find that brand still matters for sellers in a number of product markets. Jin and Kato (2006), Resnick et al. (2006), and Cabral and Hortaçsu (2010) both show how seller reputation on online auction sites is correlated with transaction prices. Given these results, it is not surprising that firms which operate online—especially those with higher costs than their competitors—try to emphasize brand and bundled services rather than the raw price of the good itself.

Ancillary service provision and branding efforts aren't the only options firms use to soften price competition. Ellison and Ellison (2009a) document active efforts by online sellers of computer CPUs and memory cards to obfuscate their true prices in order to defeat the price-comparison abilities of e-commerce technologies. In this market, both the products and sellers are viewed by consumers as homogeneous, so many sellers focus their efforts on "bait-and-switch"-type tactics where a bare-bones model of the product (often missing key parts most users would find necessary for installation) is priced low to grab top rankings on online-price-comparison websites (aka shopbots), while the additional necessary parts are marked up considerably. Ellison and Ellison describe this market as hosting a constant battle between sellers trying to find new ways to hide true prices from the shopbots (while making posted prices look very low) while the shopbot firms adjust their information gathering algorithms to better decipher goods' actual prices.

However, Baye and Morgan (2001) make an interesting point about shopbots and other product comparison websites. Building a perfect shopbot—one that exactly reports all information relevant to consumers' purchasing decisions, allowing them to find their highest-utility options almost costlessly—may not be an equilibrium strategy in markets where products are differentiated primarily by price or other vertical attributes. If a product comparison site works too well, it would destroy the very dispersion in price or other attributes it was created to address, obviating the need for its services. Baye and Morgan show that product comparison websites should provide enough information to be useful for searching customers (on whom the sites rely for revenues, either through subscriptions as in the model or, more often in practice, through advertising revenues), but not so useful as to eliminate their raison d'etre.

These active efforts by e-commerce firms are reasons why, as documented by Baye, Morgan, and Scholten (2007) and the studies cited therein, substantial price dispersion remains in most online markets. See chapter xx in this Handbook for extensive discussion of price comparison sites.

4.2. Other Market Outcomes

The advent of online sales in a product market is likely to affect more than just prices. Reduced consumer search costs or differential changes in distribution costs across producers can lead to a wave of creative destruction that shifts the fundamental structure of an industry.

Because e-commerce technologies make it easier for consumers to find lower-price sellers, lower-cost firms (or those able to deliver higher quality at the same cost) will grab larger shares of business away from their higher-cost competitors. Even if, as discussed above, the more competitive landscape created by lower search costs reduces prices and margins, this market structure response could be large enough that low-cost firms actually become more profitable as e-commerce spreads. High-cost firms, on the other hand, are doubly hit. Not only does their pricing power fall, their market share falls too, as customers who were once captive—either because of ignorance or lack of alternatives—flee to better options elsewhere. Some of these firms will be forced out of business altogether.

Conventional wisdom suggests that market structure impacts could be large; the rapid growth of online travel sites at the expense of local travel agencies is one oft-cited example. While many academic studies of the effect of e-commerce on prices exist, a small set of studies have investigated which businesses most benefit and most suffer from e-commerce.

Goldmanis et al. (2010) flesh out how such shifts could happen in a model of industry equilibrium where heterogeneous firms sell to a set of consumers who differ in their search costs. Firm heterogeneity arises from differences in marginal costs, though the model can be easily modified to allow variation in product quality levels instead. Industry consumers search sequentially when deciding from whom to buy. Firms set prices given consumers' optimal search behavior as well as their own and their rivals' production costs. Those firms that cannot cover their fixed costs exit the industry, and initial entry into the industry is governed by an entry cost.

Interpreting the advent and diffusion of e-commerce as a leftward shift in the consumer search cost distribution, Goldmanis et al. show that, consistent with previous literature, opening the market to online sales reduces the average price in the market. The more novel implications regard the equilibrium distribution of firm types, however. Here the model predicts that introducing e-commerce should result in the shrinking and sometimes exit of low-type (i.e., high-cost) firms, a shift in market share to high-type (low-cost) firms. New entrants will on average have lower costs than the average incumbent (including those firms that are forced out of the market).

Testing the model's predictions in three industries perceived to have been considerably impacted by e-commerce—travel agencies, bookstores, and new auto dealers—Goldmanis et al.

find support for these predictions. While they cannot measure costs directly in their data, they use size to proxy for firms' costs. (A considerable body of research has documented that higher cost firms in an industry tend to be smaller; see, e.g., Bartelsman and Doms (2000)). They find that growth in consumers' online shopping is linked to drops in the number of small (and presumably high-cost) establishments, but has either no significant impact or even positive impact on growth in the industries' numbers of large establishments. Further, in addition to these industry-wide shifts, e-commerce's effects varied by local markets among bookstores and new car dealers. Cities where consumers' internet use grew faster in a particular year saw larger drops (gains) in the number of small (large) bookstores and car dealers over the same year. This also informs the discussion about whether online sales truly eliminate spatial boundaries in markets.[16] The effects among car dealers are particularly noteworthy in that, in the United States, car manufacturers and dealers are legally prohibited from selling cars online. Therefore any effects of e-commerce must be channeled through consumers' abilities to comparison shop and find the best local outlet at which to buy their car, not through changes in the technology dealers use to deliver cars. While this technology-based channel is important in some industries, the consumer-side search channel is the one posited in their model, and therefore new car dealers offer the most verisimilitude to the theory from which they derive their predictions.

We add to Goldmanis et al.'s original data and specifications here. Figure 1 shows how the composition of employment in the same three industries changed between 1994 and 2007. Each panel shows the estimated fraction of employment in the industry that is accounted for by establishments of three employment size classes: those having 1-9 employees, those with 10-49, and those with 50 or more.[17] In addition to the three industries studied in Goldmanis et al., the figure also shows for the sake of comparison the same breakdown for total employment in the

[16] The aggregate impact observed among travel agencies resulted from the nature of the institutional shifts in industry revenues that e-commerce caused. Responding to a shift in customers toward buying tickets online, airlines cut ticket commissions to travel agents, which accounted for 60 percent of industry revenue in 1995, completely to zero by 2002. These commission cuts were across the board, and did not depend on the propensity of travelers to buy tickets online in the agents' local markets.

[17] County Business Patterns do not break out actual total employment by size category, so we impute it by multiplying the number of industry establishments in an employment category by the midpoint of that category's lower and upper bounds. For the largest (unbounded) size categories, we estimated travel agency offices and bookstores with 100 or more employees had an average of 125 employees; auto dealers with more than 250 employees had 300 employees. Imputations were not necessary in the case of the total nonfarm business sector, as the CBP do contain actual employment by size category in that case.

entire County Business Patterns coverage frame (essentially all establishments in the private nonfarm business sector with at least one employee).

Panel A shows the breakdown for travel agencies. It is clear that during the early half of the sample period, which saw the introduction and initial diffusion of e-commerce, the share of industry employment accounted for by travel agency offices with fewer than 10 employees shrank considerably. This lost share was almost completely taken up by establishments with 50 or more employees. After 2001, the share losses of the smallest offices stabilized, but the 10-49 employee office category then began to lose some share to the largest establishments. Therefore the predictions of the theory still hold—the largest offices in the industry benefit at the cost of the smaller offices.

Panel B shows the same results for bookstores. Here, the pattern is qualitatively similar, but even more stark quantitatively. While the fraction of employment at stores with 10-49 employees is roughly stable over the entire period, the largest bookstores gained considerable share at the expense of the smallest.

Panel C has the numbers for new car dealers. In this industry, establishments with fewer than 10 employees account for a trivial share of employment, so the interest is in the comparison between the 10-49 employee dealers and those with more than 50. Again, we see that the large establishments accounted for more and more of industry employment as time moved along, with the largest establishments gaining about 10 percentage points of market share at the cost of those with 10-49 employees.

Finally, panel D does the same analysis for all establishments in the private nonfarm business sector. It is apparent that the shifts toward larger establishments seen in the three industries of focus were not simply reflecting a broader aggregate phenomenon. Overall, employment shares of establishments in each of the three size categories were stable throughout the period.

These predictions about the market share and entry and exit effects of introducing an online sales channel in an industry are based on the assumption that firms behave non-cooperatively. If e-commerce technologies instead make it easier for firms to collude in certain markets, e-commerce technologies might actually make those markets more monopolistic (in terms of outcomes, if not in the number of firms). Campbell, Ray, and Muhanna (2005) use a dynamic version of Stahl (1989) to show theoretically that if search costs are high enough

initially, e-commerce-driven reductions in search costs can actually make it easier for collusion to be sustained in equilibrium, as they increase the profit difference between the industry's collusive and punishment (static Nash Equilibrium) states.

A more direct mechanism through which online sales channels support collusion is that the very transparency that makes it easier for consumers to compare products can also make it easier for colluding firms to monitor each other's behavior, making cheating harder. Albæk, Møllgaard, and Overgaard (1997) document an interesting example of this, albeit one that doesn't directly involve online channels, in the Danish ready-mixed concrete industry. In 1993, the Danish antitrust authority began requiring concrete firms to regularly publish and circulate their transactions prices. Within a year of the institution of this policy, prices increased 15-20 percent in absence of any notable increases in raw materials costs or downstream construction activity. The policy—one that, ironically, was implemented with hopes of increasing competition—facilitated collusion by making it easier for industry firms to coordinate on anticompetitive prices and monitor collusive activities. Online markets are often characterized by easy access to firms' prices. If it is hard for firms to offer secret discounts because of market convention, technological constraints, or legal strictures, this easy access fosters a powerful monitoring device for colluders.

5. Implications of Online Commerce for Firm Strategy

The fundamental effects of opening a concurrent online sales channel in an industry that we discussed in Section 3 can have implications for firms' competitive strategies. These strategy choices can in turn induce and interact with the equilibrium changes we discussed in Section 4. This section reviews some of these strategic factors.

A key parameter—perhaps *the* key parameter—that influences firms' strategies toward approaching offline and online markets is the degree of connectedness between online and offline markets for the same product. This connectedness is multidimensional. It includes the demand side: how closely consumers view the two channels as substitutes. It includes the supply side: whether online and offline distribution technologies are complementary. And it includes firms' available strategy spaces: how much leeway firms have in conducting separate strategic trajectories. This is particularly salient as it regards how synchronized a firm's pricing must be across offline and online channels.

At one extreme would be a market where the offline and online channels are totally separated: consumers view the product as completely different depending upon the channel through which it is sold (perhaps there are even two separate customer bases, one online and one offline); there are no technological complementarities between the two channels; and firms can freely vary positioning, advertising, and pricing of the same product across the channels. In this case, the two channels can be thought of as independent markets. A firm can operate in both the online and offline segments, but there is no scope for strategic behavior that relies upon the interplay between the two channels. Note that this does *not* have to mean that a firm's behavior is symmetric across the two channels. The economic fundamentals in each channel may differ. For example, there could be lower consumer search costs or distribution costs in the online channel. This would result in different optimal prices, disparate numbers of competitors, or even different entry decisions for the firm across the channels (it may want to enter one channel but not the other). The independence of the market segments means that the strategic choices of the firm are also independent; the firm does not need to take into account the impact of its actions in one channel on outcomes in the other. From the perspective of economic analysis, the firm's behaviors in either channel can simply be treated in isolation, taking as given each market's demand- side and technological fundamentals and using standard conceptual frameworks to model the firm's behavior.

Of more interest to us here—and where the research literature has had to break new ground—are cases where there are nontrivial interactions between online and offline channels selling the same products. We'll discuss some of the work done in this area below, categorizing it by the device through which the online and offline are linked: consumer demand (e.g., substitutability), technological complementarities, or strategic restrictions.

5.1. Online and Offline Channels Linked Through Consumer Demand

One way the online and offline sales channels can be connected is in the substitutability that buyers perceive between the channels. The extent of such substitutability determines two key, related effects of opening an online channel in a market: the potential for new entrants into an online channel to steal away business from incumbents, and the amount of cannibalization offline incumbents will suffer upon opening an online segment. Note that not every one of a market's consumers needs to view this substitutability symmetrically. There can be distinct

segments of the consumer population that react differently to the presence of online purchase options. The observed substitutability simply reflects the aggregate impact of these segments' individual responses.

These factors have been discussed in several different guises in the literature investigating the strategic implications of operating in a market with both online and offline channels. Dinlersoz and Pereira (2007), Koças and Bohlmann (2008), and Loginova (2009) construct models where heterogeneity in consumers' views toward the substitutability of products sold in the two segments affects firms' optimal online strategies.

Dinlersoz and Pereira (2007) and Koças and Bohlmann (2008) construct models where some customers have loyalty for particular firms and others are "switchers" who buy from the lowest-price firm they encounter. This implies that offline firms with large loyal segments stand to lose more revenue by lowering their prices to compete in the online market for price-sensitive switchers. Hence the willingness of incumbents from the offline segment to enter new online markets depends in part on the ratios of loyal customers to switchers. Additionally, this also means the success of pure-play online firms is tied to the number of switchers. In some circumstances, opening an online channel can lead to higher prices in the offline market, as the only remaining consumers are loyals who do not perceive the offline option as a substitute. Depending on the relative valuations and sizes of loyal and switcher segments, it is even possible that the quantity-weighted average price in the market increases. In effect, the online channel has become a price discrimination device.

Direct tests of these papers are difficult because consumers' preference parameters are unobserved. However, these models assume that if we compare two firms, the one with the higher price will have more loyal consumers than the other. We can conduct a rough test of this assumption for the bookselling industry using the Forrester Technographics data. In it, consumers are asked whether they have shopped (either online or offline) at Amazon or Barnes & Noble in the previous thirty days. A first test is to see what fraction of consumers shopped only at Amazon or Barnes & Noble (or both). Clay et al. (2002) found that Amazon set prices higher than Barnes & Noble and that Barnes & Noble set prices higher than Borders. Thus, the models predict that Amazon's customers will be slightly more loyal than Barnes & Noble's and that Barnes & Noble's customers will be more loyal than Borders'. In our test, this implies that

of people who shop at these stores, the highest fraction will shop only at Amazon, followed by Barnes & Noble and Borders relative to the size of the group that shops at multiple stores.

The results are in Table 6. In the first row, the first column reports the fraction of consumers who purchased a book in the past three months and shopped only at Amazon. the second column gives the fraction of customers who purchased a product from Amazon as well as from Barnes & Noble or Borders.com. The first column corresponds to the loyals while those in the second column are switchers. If we take this crude measure as reflecting the loyalty of the booksellers' customer bases, then Barnes & Noble has a more loyal base. When we compare the size of the loyals to switchers for any given store, we see that Amazon and Barnes & Noble are very similar while Borders has a significantly higher ratio. Yet the fact that Amazon charges higher prices in the data is inconsistent with the model's prediction that the firm with more loyal customers or a lower ratio of switchers to loyals, Barnes & Noble, should price higher.

There is a caveat to this result, however. It could be confounded by internet use. The models' predictions regard the loyalty of a firm's online customers. If a large fraction of Barnes & Noble's "loyal" segment is offline customers, then we might be overstating the loyalty of Barnes & Noble's online consumers. In the second panel of Table 6, we focus on online consumers by recalculating the fractions after conditioning on the consumer having purchased a book online. Here, we find evidence that is more in line with the predictions of Dinlersoz and Pereira (2007) and Koças and Bohlmann (2008). The highest price firm has the most loyals and the lowest ratio of switchers to loyals.

In Loginova (2009), consumers' lack of knowledge about their valuation for a good ends up linking the online and offline markets. Consumers in her model differ in their valuations for the market good, but do not realize their valuation until they either a) visit an offline retailer and inspect the good, or b) purchase the good from an online retailer (no returns are allowed). Under certain parameter restrictions, there is an equilibrium where both channels are active and all consumers go to offline retailers and learn their valuations. Upon realizing their utility from the good, they decide either to purchase the good immediately from the offline retailer or to go home and purchase the product from an online retailer while incurring a waiting cost. This can allow equilibrium market segmentation where consumers with low valuations buy from the online stores while high-valuation consumers buy immediately at the offline outlet they visited. The segmentation allows offline retailers to raise their prices relative to their level in a market

without an online purchase option. Because of the imperfect substitutability of goods online for offline, firms are able to avoid head-on competition by segmenting the market and only selling to a particular fraction of consumers.

A different set of strategic issues are at play if the products sold via a market's online and offline channels are complements rather than substitutes. Empirical evidence on this issue is relatively sparse, but a study by Gentzkow (2007) shows the difficulty of deducing complementarities by naively observing correlations in consumption patterns. Gentzkow estimates the extent to which the online edition of the *Washington Post* is a complement or substitute for the print edition. The most basic patterns in the data suggest they are complements: consumers who visited the paper's website within the last five days are more likely to have also read the print version. However, this cross sectional pattern is confounded by variation in individuals' valuations from consuming news. It could be that some individuals simply read a lot of media, and often they happen to read the online and offline versions of the paper within a few days of one another. But conditioning on having read one version, *that specific individual* may be less likely to read the other version. This is borne out in a more careful look at the data; when Gentzkow instruments for whether the consumer has recently visited the paper's website using shifters of the consumer's costs of reading online, the two channels' versions are estimated to be rather strong substitutes. Using a different methodology, Biyalogorsky and Naik (2003) find similarly that when Tower Records began selling online, it suffered some cannibalization, on the order of 3 percent of the bricks-and-mortar sales. Record stores, of course, have suffered more generally from online competition, suggesting that across-firm substitution has been a much larger issue in that market than within-firm cannibalization.

Thus while there is not much empirical evidence on the question of cannibalization caused by expansion to the internet, the available evidence supports a role for cannibalization. One potential complementarity that these analyses do not address, however, extends beyond the products themselves. Specifically, the wealth of data generated from online sales could help firms to market certain products to individuals much more efficiently and lead to increased sales in both channels (Jones 2010).

5.2. Online and Offline Channels Linked Through Technological Complementarities

In Wang (2007), the tie between the two channels is a general complementarity reflected in the profit function; Wang uses the specific interpretation of a technological complementarity. His model follows the evolution of an industry after the internet has been introduced. This introduction is treated as the opening of a new market segment which reduces entry costs.

The model's dynamic predictions are as follows. Taking advantage of the new, lower entry costs, pure-play online sellers enter first to compete with the brick-and-mortar incumbents. But the complementarity between the online sales and distribution technology and the offline technology gives offline incumbents incentive to expand into the online channel. It also gives these firms an inherent advantage in the online market, as they are able to leverage their offline assets to their gain. As a result, many of the original online-only entrants are pushed out of the industry. Thus a hump-shaped pattern is predicted in the number of pure-play online firms in a product market, and a steady diffusion of former offline firms into the online channel.

This is a reasonably accurate description of the expansion in the online sectors of many retail and service markets. Many of the online leaders were pure-play sellers: Amazon, E-Trade, Hotmail, pets.com, and boo.com, for example. But many of these online leaders exited the market or were subsumed by what were once offline incumbents. Some pure-play firms still exist and a few are fabulously successful franchises, but at the same time, many former brick-and-mortar sellers now dominate the online channels of their product markets as well.

5.3. Online and Offline Channels Linked Through Restrictions on Strategy Space

Liu, Gupta, and Zhang (2006) and Viswanathan (2005) investigate cases where the online and offline channels are tied together by restrictions on firms' strategy spaces—specifically, that their prices in the two channels must be a constant multiple of one another. In the former study, this multiple is one: the firm must price the same whether selling online or offline. Viswanathan (2005) imposes that the price ratio must be a constant multiple, though not necessarily unity. While it might seem curious for these pricing constraints to be exogenously imposed instead of arising as equilibrium outcomes, it is true that certain retailers have faced public relations and sometimes even legal problems due to differences in the prices they charge on their websites and in their stores. Liu, Gupta, and Zhang relate that many multichannel firms report in surveys that they price consistently across their offline and online channels (e.g., Forrester Research (2004)).

Liu, Gupta, and Zhang (2006) show that, when the equal pricing restriction holds, an incumbent offline seller can deter the entry of a pure-play online retailer by *not* entering the online market itself. This seemingly counterintuitive result comes from the requirement that the incumbent must charge the same price in the two channels. An incumbent moving into the online channel with its hands tied in this way is restricted in its ability to compete on price, because any competition-driven price decrease in the online market lowers what the incumbent earns on its inframarginal offline units. This limitation to its strategy space can actually weaken the incumbent's competitive response so much that a pure-play online retailer would be more profitable if the incumbent enters the online segment (and therefore has to compete head-to-head with one hand tied behind its back) than if the incumbent stays exclusively offline. Realizing this, the incumbent can sometimes deter entry by the pure-play online firm by staying out of the online channel in the first place. So in this model, the link across the online and offline channels creates an interesting situation in which the offline firm does not gain an advantage by being the first mover in to the online channel. Instead, it may want to abstain from the online market altogether.

Viswanathan (2005) models the online and offline models as adjacent spatial markets. Consumers in one market cannot buy from a firm in the other market. However, one firm at the junction of the two markets is allowed to operate as a dual-channel supplier, but it must maintain an exogenously given price ratio of k between the two markets. Viswanathan shows that in this setup, the price charged by the two-channel firm will be lower than the offline-only firms' prices but higher than the pure-play online sellers.

6. Conclusions

The emergence of online channels in a market can bring substantial changes to the market's economic fundamentals and, through these changes, affect outcomes at both the market level and for individual firms. The potential for such shifts has implications in turn for firms' competitive strategies. Incumbent offline sellers and new pure-play online entrants alike must account for the many ways a market's offline and online channels interact when making pricing, investment, entry, and other critical decisions.

We have explored several facets of these interactions in this chapter. We stress that this is only a cursory overview, however. Research investigating these offline-online connections is

already substantial and is still growing. This is rightly so, in our opinion; the insights drawn from this literature will expectedly only become more salient in the future. Online channels have yet to fully establish themselves in some markets and, in those markets where they have been developed, are typically growing faster than bricks-and-mortar channels. This growing salience is especially likely in the retail and services sectors, where online sales appear to still have substantial room for growth.

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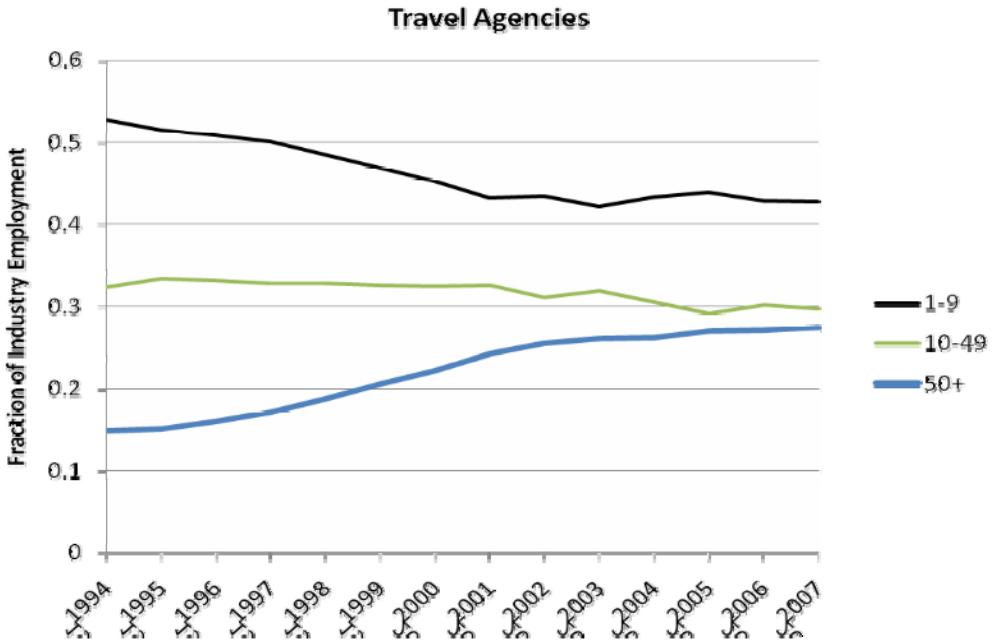
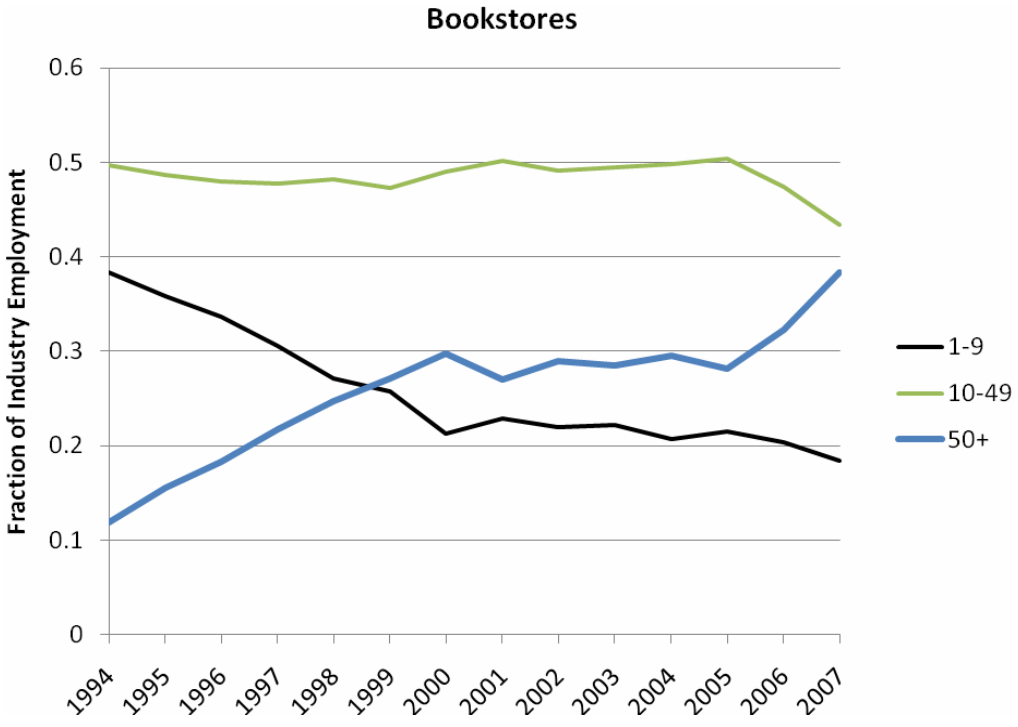
Figure 1. Estimated Share of Industry Employment by Establishment Size

Panel A.



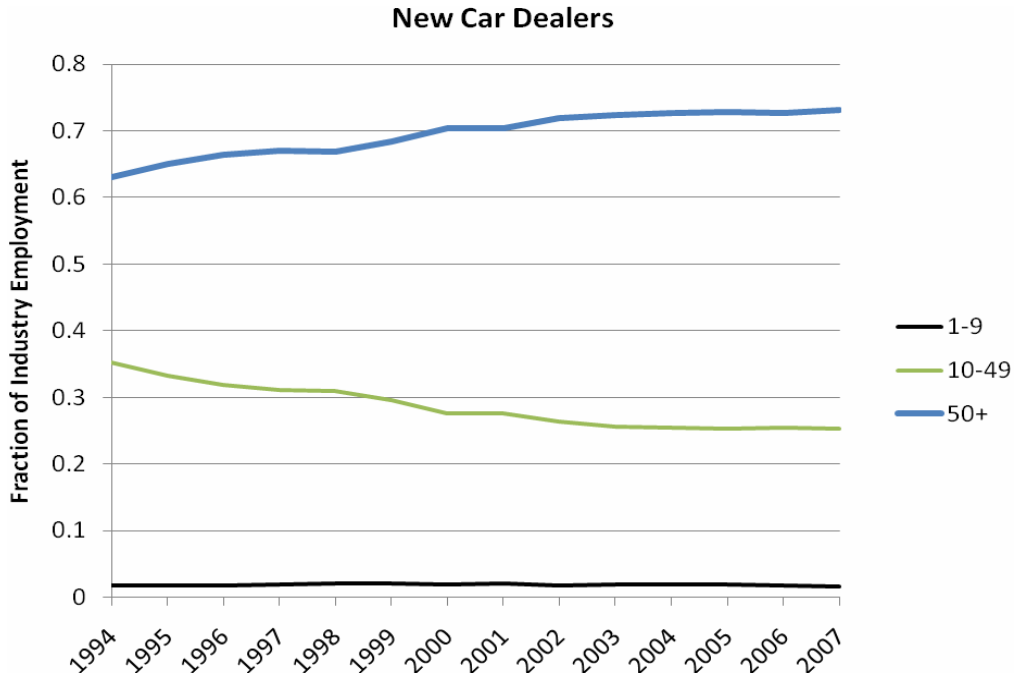
Source: County Business Patterns data.

Panel B.



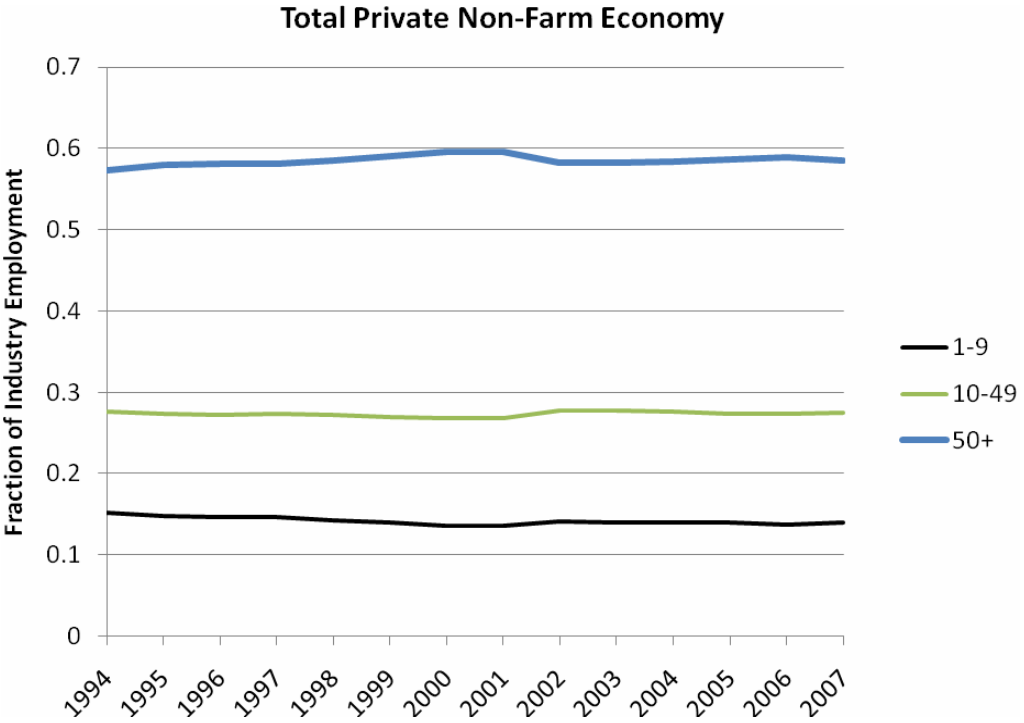
Source: County Business Patterns data.

Panel C.



Source: County Business Patterns data.

Panel D.



Source: County Business Patterns data.

Table 1. Dollar Value of Commerce by Sector and Type ($ billions)

		2002	2008	Percent gain, 2002-2008
Manufacturing	E-commerce	751.99	2154.48	186.51
	Offline	3168.65	3331.78	5.15
	Fraction e-commerce	0.192	0.393	
Wholesale	E-commerce	806.59	1262.37	56.51
	Offline	3345.01	4853.79	45.11
	Fraction e-commerce	0.194	0.206	
Retail	E-commerce	44.93	141.89	215.84
	Offline	3089.40	3817.27	23.56
	Fraction e-commerce	0.014	0.036	
Service	E-commerce	59.97	146.49	144.29
	Offline	4841.03	6700.97	38.42
	Fraction e-commerce	0.012	0.021	
Total	E-commerce	1,663.47	3,705.23	122.74
	Offline	14,444.09	18,703.81	29.49
	Fraction e-commerce	0.103	0.165	

Data are from U.S. Census E-commerce Reports available at <http://www.census.gov/econ/estats/>.

Table 2. Demographics and Probability of Using Internet and Purchasing Online

	Use Internet	Purchase Online
Respondent's race is Black	-0.039	-0.106
	(0.007)***	(0.009)***
Respondent's race is Asian	0.029	0.01
	(0.014)**	(0.018)
Respondent's race is other	0.005	-0.002
	(0.015)	(0.020)
Respondent is Hispanic	0.005	-0.002
	(0.009)	(0.012)
Respondent is Male	-0.005	-0.009
	(0.005)	(0.006)
Household income < $20K	-0.217	-0.309
	(0.015)***	(0.011)***
$20K < household income ≤ $30K	-0.134	-0.207
	(0.013)***	(0.012)***
$30K < household income ≤ $50K	-0.085	-0.133
	(0.011)***	(0.011)***
$50K < household income ≤ $70K	-0.043	-0.085
	(0.011)***	(0.011)***
$70K < household income ≤ $90K	-0.004	-0.038
	(0.010)	(0.011)***
$90K < household income ≤ $125K	-0.017	-0.043
	(0.010)	(0.011)***
Female head of household's education is less than high school	-0.081	-0.109
	(0.009)***	(0.012)***
Female head of household's education is college	0.063	0.083
	(0.005)***	(0.006)***
Male head of household's education is less than high school	-0.091	-0.134
	(0.008)***	(0.010)***
Male head of household's education is college	0.084	0.109
	(0.004)***	(0.006)***
Age	-0.004	-0.003
	(0.001)***	(0.001)**
$Age^2/1000$	-0.025	-0.085
	(0.007)***	(0.011)***
Additional income and family structure controls	X	X
Fraction of sample responding yes	0.763	0.509
N	54,320	54,320
Pseudo-R^2	0.240	0.196

Notes: The data are from Forrester Research's 2005 Technographics Survey. Reported coefficients are estimated marginal effects from probit regressions. Included controls but without coefficients shown are: dummies for value of household assets, value of retirement account, home ownership status, occupation categories, marital status, household size, and if there are any children younger than 18 present. *Significant at the 10 percent level. **Significant at the 5 percent level. ***Significant at the 1 percent level.

Table 3. Probability of Purchasing Financial Products Online

		Financial Products	
	Any product	Unconditional	Conditional on purchasing
Respondent's race is Black	-0.106	0.015	0.058
	(0.009)***	(0.004)***	(0.013)***
Respondent's race is Asian	0.01	0.035	0.107
	(0.018)	(0.009)***	(0.023)***
Respondent's race is other	-0.002	0.001	0.019
	(0.020)	(0.008)	(0.023)
Respondent is Hispanic	-0.002	0.015	0.054
	(0.012)	(0.006)**	(0.016)***
Respondent is Male	-0.009	0.015	0.033
	(0.006)	(0.003)***	(0.008)***
Household income < $20K	-0.309	-0.048	-0.107
	(0.011)***	(0.004)***	(0.014)***
$20K < household income ≤ $30K	-0.207	-0.026	-0.062
	(0.012)***	(0.005)***	(0.015)***
$30K < household income ≤ $50K	-0.133	-0.017	-0.049
	(0.011)***	(0.005)***	(0.014)***
$50K < household income ≤ $70K	-0.085	-0.012	-0.035
	(0.011)***	(0.005)***	(0.013)***
$70K < household income ≤ $90K	-0.038	-0.003	-0.008
	(0.011)***	(0.005)	(0.013)
$90K < household income ≤ $125K	-0.043	-0.006	-0.016
	(0.011)***	(0.005)	(0.013)
Female head of household's education is less than high school	-0.109	-0.011	-0.014
	(0.012)***	(0.005)**	(0.016)
Female head of household's education is college	0.083	-0.005	-0.013
	(0.006)***	(0.003)*	(0.008)
Male head of household's education is less than high school	-0.134	-0.021	-0.051
	(0.010)***	(0.004)***	(0.012)***
Male head of household's education is college	0.109	0.003	0.008
	(0.006)***	(0.003)	(0.008)
Age	-0.003	-0.005	-0.006
	(0.001)**	(0.001)***	(0.001)***
$Age^2/1000$	-0.085	0.015	-0.006
	(0.011)***	(0.005)***	(0.014)
Fraction of sample responding yes	0.509	0.096	0.265
N	54,320	59,173	21,474
Pseudo-R^2	0.196	0.097	0.086

Notes: The data are from Forrester Research's Technographics Survey. Reported coefficients are estimated marginal effects from probit regressions. Included controls but without coefficients shown are: dummies for value of household assets, value of retirement account, home ownership status, occupation categories, marital status, household size, and if there are any children younger than 18 present. *Significant at the 10 percent level. **Significant at the 5 percent level. ***Significant at the 1 percent level.

Table 4. Changes in Consumers' Propensity to Buy Products Online, 2002-2007

Product category	Pct. growth in online purchase frequency, 2002-2007	Fraction buying product online, 2007
Car insurance	183.7	0.076
Major appliances	139.6	0.014
Consumer electronics	125.7	0.092
Video games	117.3	0.070
Sporting goods	100.8	0.068
Footwear	89.8	0.116
Credit card	77.2	0.102
Apparel	73.6	0.253
Auto parts	64.3	0.039
Books	60.3	0.278
DVDs	58.6	0.148
Event tickets	53.2	0.121
Music	48.3	0.156
Computer hardware	43.0	0.076
Life insurance	42.2	0.019
Toys	41.2	0.124
Hotel reservations	31.1	0.151
Clothing accessories	23.6	0.089
Airline tickets	22.2	0.172
Tools/hardware	21.0	0.045
Office supplies	19.1	0.077
Software	12.7	0.113
Flowers	11.0	0.097
Car loans	6.3	0.024
Car rentals	6.2	0.077
Food/beverages	-1.1	0.041
Home equity loans	-3.5	0.018
Mortgages	-25.4	0.025
Small appliances	-32.8	0.022

Notes: The data are from Forrester Research's Technographics Survey.

Table 5. Relationship between Fraction Purchasing Products Online and Number of Online Firms within Local Markets

	Total online only firms	Online only firms of given size					
		1-4	5-9	10-19	20-49	50-99	100+
	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Fraction purchasing online in market	22.29***	14.87**	3.714**	2.136**	1.318*	0.211	0.049
	(6.190)	(4.535)	(1.234)	(0.719)	(0.669)	(0.315)	(0.345)
Year FEs	x	x	x	x	x	x	x
Market FEs	x	x	x	x	x	x	x
Mean of dependent variable	39.16	23.31	6.73	4.24	2.65	0.94	1.29
R^2	0.963	0.947	0.942	0.941	0.914	0.856	0.920
N	3378	3378	3378	3378	3378	3378	3378

Notes: The firms data are from County Business Patterns and the fraction of people purchasing products online are from Forrester Research's Technographics Survey. All regressions include a control for the total number of people employed in that CEA and use data from 1998-2007. Standard errors clustered at the CEA level are given in parentheses.

Table 6. “Switchers” and “Loyals” in the Book Industry

	Consumers Who Purchased Books in Past Three Months		
	Loyals	Switchers	Switchers/Loyals
Amazon.com	0.201	0.203	1.009
Barnes & Noble	0.279	0.278	0.996
Borders	0.087	0.153	1.764
	Consumers Who Purchased Books Online in Past Three Months		
Amazon.com	0.343	0.262	0.765
Barnes & Noble	0.179	0.274	1.527
Borders	0.034	0.095	2.826

Data are from Forrester Research's Technographics Survey. Each entry under "Loyals" gives the fraction of customers who purchased only from one of the three firms while "Switchers" are customers that purchased from more than one of the three firms listed. The third column gives the ratio of switchers to loyals for each firm. The top panel includes all consumers who purchased books, whether online or offline while the lower panel only includes consumers who purchased books online.