Online vs. Offline Competition*

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Ethan Lieber
University of Chicago
elieber@uchicago.edu

and

Chad Syverson
University of Chicago
Booth School of Business
and NBER
chad.syverson@chicagobooth.edu

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1. Introduction

Amazonis arguably one of the most successful online firms. As of this writing, its market value is over $79 billion, 40 percent higher than 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 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 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? Start their own online operation? If 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—actions driven by the changes in market fundamentals wrought by the diffusion of e-commerce technologies into 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 discuss the nature of competition between a market's online and offline segments. We take a broad view rather than focus on a specific case study, but many of

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

the elements that drove the evolution of retail bookselling as just described are present 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; the heterogeneity in online sales intensity across different sectors, industries, and firms; and the characteristics of consumers who buy online. Section 3 discusses how markets' online channels are economically different due to e-commerce's effects on market demand and supply fundamentals. Section 4 explores how changes in these fundamentals due to 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 that reflect the present state 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 comprehensive e-commerce information collected by the U.S. Census Bureau.[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.

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 manufacturing

[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." 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).

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 sales in B2B sectors 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 to conduct business was already common before the expansion 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 in mind the somewhat distinct focal points of the data and the literature.

2.2. Who Sells Online?

In addition to the variation in online sales intensity across broad sectors, there is also considerable heterogeneity within sectors. Within manufacturing, the share of online-related sales ranges from 21 percent in Leather and Allied Products to 54 percent in Transportation

[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.

Equipment. In retail, less than one third of one percent of sales at Food and Beverage stores are online; on the other hand, online sales account for 47 percent of all sales in the Electronic Shopping and Mail-Order Houses industry (separately classified in the NAICS taxonomy as a 4-digit industry). 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 some logistical aspects of these businesses, such as advertising and billing, can be 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.

In an attempt to explain the heterogeneity in the online channel's share of sales across manufacturing industries, we compared an industry's e-commerce sales share to a number of plausible drivers of this share. These include 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. (All variables were measured at the 3-digit NAICS level.[5]) We did not find clear connections of industries' e-commerce sales shares to these potential drivers in either raw pairwise correlations or in a regression framework, though our small sample size makes inference difficult. The tightest link was between e-commerce intensity and the logged value per ton of the industry's output. A one-standard-deviation increase in the latter was related to a roughly half-standard-deviation increase in e-commerce's sales share. The statistical significance of this connection was marginal (the p-value is 0.101), however.

Forman et al. (2003) study sources of differences in online sales activity across *firms* by investigating commercial firms' investments in e-commerce capabilities. They do so using the Harte Hanks Market Intelligence CI Technology database from June 1998 through December of 2000, which contains information on technology use for over 300,000 establishments. The authors use this data to classify investments in e-commerce capabilities into two categories:

[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.

participation and enhancement. The former involves developing basic communications capabilities like email, maintaining an active website, and allowing passive document sharing. Enhancement involves adopting technologies that alter internal operations or lead to new services. They found that most firms, around 90 percent, made *some* sort of technology investment. However, only a small fraction (12 percent) adopted internet technologies that fell into the enhancement category. So while most firms adopted internet technologies, only a few made investments that would fundamentally change their business.[6]

2.3. Who Buys Online?

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

We first look at who uses the internet in any regular capacity (not necessarily to shop). We run a probit regression of an indicator for internet use by the respondent during the previous year on a number of demographic variables. The estimated marginal effects are in Table 2, column 1. By the time of the 2005 survey, more than 75 percent of the sample reported being online, so the results do not simply 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.

Education is 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 education variables for both the female and male household heads), while having a college degree raises it by 6 to 8 points.

[6] The two-digit NAICS industry with the highest enhancement category investment rate (28 percent) was Management of Companies and Enterprises (NAICS 55). The lowest adoption rate (6.2 percent) was in Educational Services (NAICS 61).

Not surprisingly, the propensity to be online declines with age. The coefficient on the square of age is negative and significant, so 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 internet use.

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 similar to those for the probit on internet use, though many marginal effects have larger magnitudes. 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 (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, as the magnitude of the age effect is still convex. While 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 of purchases 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 results 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 investigate consumers' behavior 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 2 regarding whether the respondent made any purchase online within the past 12 months. Columns 2 and 3 of Table 3 report analogous results for probits on whether the respondent bought any of the particular financial products listed above online within the past year. The results in column 2 do not condition on the respondent having reported that they researched such financial products online; those in column 3 use the subsample of respondents reporting having researching those product types online. The results from both samples are similar.

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. While Blacks are 11 percentage points less likely to purchase products online than Whites, they are 1.5 percentage points *more* likely to buy financial products online. Not only is this effect in the opposite direction of the overall results, it is almost as large in magnitude in relative terms.[7] Asian and Hispanic respondents are similarly more likely (economically and statistically) to buy financial products online than Whites, even though they did not exhibit statistically different 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.

[7] Note that when comparing the magnitudes of the coefficient estimates across columns in Table 3, one should be mindful of the average probability of purchase in the sample, p_{bar}, 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.

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. The third column shows for reference the fraction of consumers reporting having bought the product online in the past year. Auto insurance, one of the financial products we just discussed, saw the fastest growth in online purchases, nearly tripling between 2002 and 2007 (though from an initially small level). 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.[8] While the growth rate of online purchases for a product is negatively correlated with its 2002 level, the correlation is modest (ρ = -0.13) and not significantly different from zero. Thus it is not the case that the fastest growing products were those that had the slowest start.

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

E-commerce technology can affect both 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 may have less brand or reputation capital to signal or bond quality. These factors can create information asymmetries between buyers and sellers not present in offline purchases. Online sales also often involve a delay between purchase and 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 supply chain costs, 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.

[8] 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.

3.1. 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 online market. Another is that because online retailing is relatively new, retailers have less brand capital than established traditional retailers. A related factor involves some consumers' concerns about the security of online transactions.

Because information asymmetries can lead to market inefficiencies, both buyers and sellers (particularly sellers of high quality goods) have incentives to structure transactions and form market institutions to alleviate lemons problems. Many examples of such efforts on the part of online sellers exist. Firms such as Zappos offer free shipping on purchases and returns, which moves closer to making purchases conditional upon inspection. However, the delay between ordering and consumption inherent to online commerce (more on this below) still creates a wedge.

An alternative approach is 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 brokers 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 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 price comparison site to study the online book market. They find that brand has a

significant effect on consumer demand. 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 allow even small sellers to build reputations, although Bajari and Hortaçsu (2004) conclude that the evidence about whether a premium accrues to sellers with high ratings 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 was sold by the same seller, but using a new eBay identity without any buyer feedback history. The lots sold using the experienced seller identity received winning bids that were approximately eight percent higher. More recently, Adams, Hosken, and Newberry (2009) evaluate whether seller ratings affect how much buyers 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 (even negative) effect of seller ratings.

In another recent paper, Cabral and Hortaçsu (2010) use a different approach and find an important role for 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). Next, using a panel of sellers to examine reputation effects over time, they find that sellers' first negative feedback drops their average sales growth rates from +5% to –8%. Further, subsequent negative feedback arrives more quickly, and the seller becomes more likely to exit as her rating falls.

Outside of online auction markets, Waldfogel and Chen (2006) look at the interaction of branding online and information about the company from a third party. They find that the rise of information intermediaries such as BizRate leads to lower market shares for major branded online sellers like Amazon. Thus other sources of online information may be a useful substitute for branding in some markets.

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 delivery lags that can range from hours to days and occasionally longer. Furthermore, these delayed-consumption items are the kind of product most likely to be available in both online and brick-and-mortar stores, so the role of 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). In either case, this reduces the expected utility from purchasing the good's online version. However, more behavioral explanations hold out the possibility that, for some goods at least, the delay actually confers benefits to the buyer in the form of anticipation of a pleasant consumption experience (e.g., Loewenstein 1987). This holds out the possibility that the impact of delay on the relative advantage of online channels is ambiguous. Though one might think that if delay confers a consistent advantage, offline sellers should offer their consumers the option to delay consumption after purchase rather easily. This, to say the least, is rarely seen in practice.

3.3. Reduced Consumer Search Costs

It is generally accepted that search costs online are lower than in offline markets. The rise of consumer information sites, from price aggregation and comparison sites (aka shopbots) to product review and discussion forums, has led to large decreases in consumers' costs 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 affects how goods get from producers to consumers. In some industries, the internet has caused disintermediation, a diminishment or sometimes the entire removal of links of the supply chain. For example, between 1997 and 2007, the number of travel agency offices fell by about half, from 29,500 to 15,700. This was accompanied by a large increase in consumers' propensity to directly make travel arrangements—and buy airline tickets in particular—using online technologies.[9]

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 upstream wholesalers and manufacturers. This has reduced the need for inventory holding. Retail inventory-to-sales ratios have dropped from around 1.65 in 1992 to 1.34 in late 2010, and from 1.55 to 1.25 over the same period for "total business," a sum of the manufacturing, wholesale, and retail sectors.[10]

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. This reduces 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.[11]

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, a 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

[9] 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 go through a physical dealer who cannot be owned by a manufacturer. Given these restrictions, online technologies in the 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).

[10] http://www.census.gov/mtis/www/data/text/mtis-ratios.txt, retrieved 1/26/11.

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

inventory risk.[12] 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 because the higher costs of physically distributing such goods raises the savings from skipping the extra step of shipping from wholesaler to retailer.

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, as margins from low-volume varieties cannot cover the fixed costs of storing them 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. The combination of these technological changes lets them offer a greater variety of products for sale. (E-commerce's consumer search tools can also 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 firm like 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 reduce the costs of distributing products across wide geographies. The practice of drop-shipping discussed above is an example; not having 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 people in more isolated cities are more likely to use the internet. Similarly, Sinai and Waldfogel (2004) show that conditional on the amount of local online content, people in smaller cities are more likely to connect to the internet than those in larger

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

cities. Forman, Goldfarb, and Greenstein (2005) document that on the margin, businesses in rural areas are more likely to adopt technologies that aid communication across establishments

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. Buyers and sellers that live in the same city have particular preference for trading with one another instead of someone outside the metropolitan area. Hortaçsu et al surmise that cultural factors and the easier ability to enforce contracts, should breaches occur, explain this result. Blum and Goldfarb (2006) find geography matters online even for purely digital goods like downloadable music, pictures, and movies, where transport and other similar trade costs are nil. They attribute this to culturally correlated tastes among producers and consumers living in relative proximity. Sinai and Waldfogel (2004) find patterns consistent with broader complementarities between the internet and cities. They find in Media Metrix and Current Population Survey data that larger cities have substantially more local content online than smaller cities, and this content leads people to connect to the internet.[13]

We test whether geography matters online more generally by comparing the locations of pure-play online retailers to where people who purchase products online live. 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 with any physical presence, even if they are a hybrid operation with an online component. Hence these businesses sell exclusively at a distance. (Though they may not necessarily be online, as they could be exclusively a mail order operation. We consider the implications of this below.) We use the Technographics survey discussed above to compute the fraction of respondents in a geographic market reporting making online purchases in the previous year. Our geographic market definition is based on the Component Economic Areas (CEAs) constructed by the U.S.

[13] 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.

Bureau of Economic Analysis. CEAs are groups of economically connected counties; in many cases, they are a metro area 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 combine these data sets into an annual panel spanning 1998 to 2007.

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 market 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's human capital is both desired by online retailers and makes Valley consumers apt to shop online.[14] We further include logged total employment in the CEA in the regression to control for overall economic growth in the market, and we add year fixed effects to remove aggregate trends.

The estimate in the first numerical column 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. (Establishment counts have been scaled by 10 for better resolution of some of the correlations by business size category.) While NAICS 45411 can include mail-order businesses that do not sell online, it is seems likely that growth in pure mail-order operations within a market would either be uncorrelated or perhaps 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.

The next six columns of Table 5 report results from similar regressions that use as the dependent variable counts of NAICS 45411 establishments in various employment size categories. A given increase in online shopping is tied to a larger increase in the number of smaller establishments than bigger 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 proportionally increases the number of firms of all sizes. (Some of the growth

[14] 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.) 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.

of the number of larger establishments may well reflect existing businesses becoming larger rather than de novo entry.)

3.6. Tax Treatment

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's sales or use taxes 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.[15] 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 empirical evidence on this subject. He uses the Forrester Technographics survey to estimate that the elasticity of the probability of consumers buying products on the internet with respect to the local tax rate is about 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 supply side, tax structure can distort firm location decisions. Suppose a firm bases its operations 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

[15] The great majority of states have a sales tax; only Alaska, Delaware, Montana, New Hampshire, and Oregon do not. 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.

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, the books to be sold on BarnesandNoble.com were sent to a distribution center in Jamesburg, New Jersey. Books for traditional brick-and-mortar stores were sent to different warehousing facilities to make it clear which books would not be subject to sales tax. Further, when BarnesandNoble.com went online in May of 1997, the company initially refused to install kiosks with access to the website in stores. They also avoided delivering books ordered online to their physical stores for pick up by customers. It wasn't until October 2000 that Barnes & Noble, after struggling to compete with Amazon, 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) 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 costs.[16]

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

[16] 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) estimate that price comparison websites led to drops of 8-15 percent in the prices of term life insurance policies. 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 with cost advantages over their competitors. However, these same competitive forces can also give strong incentives to firms with cost disadvantages to limit the impact of price differentials. These firms would like to take actions that reduce the propensity of consumers, now with enhanced abilities to shop around, to shift their purchases toward lower-cost sellers.

Certainly, *some* 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's (2001) aforementioned study on brand effects in online book sales is an example. 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. And the work by Jin and Kato (2006), Resnick et al. (2006), and Cabral and Hortaçsu (2010) on seller reputation on online auction sites further bolsters the importance of such ancillary services. Given these results, it is not surprising that firms that 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 tools 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 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 shopbots, while the additional necessary parts are sold at considerable mark ups. Ellison and Ellison describe a constant battle between sellers trying to find new ways to hide true prices from the shopbots (while making posted prices look very low) and shopbot firms adjusting 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 reports all information relevant to consumers' purchasing decisions, allowing them to find their highest-utility options almost costlessly—may not be an equilibrium strategy when products are differentiated primarily by price or other vertical attributes. A product comparison site that works too well will 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. But while many academic studies of the effect of e-commerce on prices exist, only 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. 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 shrink and sometimes force the exit of low-type (i.e., high-cost) firms and shift market share to high-type (low-cost) firms. Further, new entrants will on average have lower costs than the average incumbent, including those 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 the number of the industries' large establishments. 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 above about whether online sales truly eliminate spatial boundaries in markets.[17] The effects among car dealers are particularly noteworthy in that auto manufacturers and dealers in the U.S. 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 of car distribution. 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. 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 entire County Business Patterns coverage frame (essentially all establishments in the private nonfarm business sector with at least one employee).[18]

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 category began to lose share to the largest establishments. These patterns are consistent with the predictions of the theory—the largest offices in the industry benefit at the cost of the smaller offices.

[17] 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.

[18] 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.

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 a greater fraction of industry employment over time, 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. 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 less competitive. 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. This makes 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 factor—perhaps *the* key factor—influencing firms' joint strategies toward offline and online markets is the degree of connectedness between online and offline markets for the same product. This connectedness can be multidimensional. It can involve the demand side: how closely consumers view the two channels as substitutes. It can involve the supply side: whether online and offline distribution technologies are complementary. And it can involve firms' available strategy spaces: how much leeway firms have in conducting separate strategic trajectories across channels, which 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. Specifically, consumers view the product as completely different depending upon the channel through which it is sold (perhaps there are even separate online and offline customer bases); 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, each channel can be thought of as an independent market. The firm's choices in each channel can be analyzed independently, as there is no scope for strategic behavior that relies upon the interplay between the two channels.

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 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. Not all consumers in a market need to view this substitutability symmetrically. Distinct segments can 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 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 strategies.

Dinlersoz and Pereira (2007) and Koças and Bohlmann (2008) build models where some customers have loyalty for particular firms and others buy from the lowest-price firm they encounter. Offline firms with large loyal segments ("Loyals") 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. 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 online option as a substitute. Depending on the relative valuations and sizes of the Loyals and Switchers segments, it is even possible that the quantity-weighted average price in the market increases. In effect, the online channel becomes a price discrimination device.

Direct tests of these models are difficult, but they do imply 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 in the bookselling industry using the Forrester Technographics data. In it,

consumers are asked whether they have shopped either online or offline at Amazon, Barnes & Noble, or Borders in the previous thirty days. Clay et al. (2002) found that Amazon set prices higher than Barnes & Noble, which in turn set prices higher than Borders. Thus the models predict that Amazon's customers will be more loyal than Barnes & Noble's, who are themselves more loyal than Borders'. In our test, this implies that of customers of these sellers, Amazon will have the highest fraction of exclusive shoppers, followed by Barnes & Noble and Borders.

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. If we take the first column as a crude measure of the fraction of Amazon's loyal customers and the second column as a measure of those willing to shop around, Amazon's customer base is roughly split between Loyals and Switchers. While the models would predict that, given the observed price difference, Barnes and Noble's Loyals-to-Switchers ratio should be lower, this is not the case in the data, as reflected in the second row. However, Borders' low ratio of Loyals to Switchers is consistent with them having the lowest prices. A caveat to these results, however, is that they could be confounded by internet use. The models' predictions regard the loyalty of a firm's *online* customers. If many of Barnes & Noble's loyal customers are offline, our measure might overstate the loyalty of Barnes & Noble's online consumers. We address this in the second panel of Table 6 by recalculating the fractions after conditioning on the consumer having purchased a book online. Now the evidence is exactly in line with the predictions of Dinlersoz and Pereira (2007) and Koças and Bohlmann (2008): the rank ordering of the firms' prices is the same as the ordering of the Loyals-to-Switchers ratio.

In Loginova (2009), consumers' ignorance of their valuations for a good shapes the nature of the link between online and offline markets. Consumers in her model differ in their valuations for the market good, but do not realize their valuations 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 immediately purchase the good from the offline retailer or to go home and purchase the product from an online retailer while incurring a waiting cost. This creates an equilibrium market segmentation where consumers with low valuations buy

from online stores and high-valuation consumers buy immediately at the offline outlet they visited. The segmentation lets offline retailers raise their prices above what they would be in a market without an online segment. The imperfect substitutability between online and offline goods segments the market and allows firms to avoid head-on competition.

These papers focus on the extent to which goods sold on online and offline channels are substitutes, but it is possible in certain settings that they may be complements. Empirical evidence on this issue is relatively sparse. Gentzkow (2007) estimates whether the online edition of the *Washington Post* is a substitute or complement 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 like to read a lot of media, and they often 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; instrumenting for whether the consumer has recently visited the paper's website using shifters of the consumer's costs of reading online, Gentzkow finds the two channels' versions are rather strong substitutes. Using a different methodology, Biyalogorsky and Naik (2003) look whether Tower Records' introduction of an online channel lifted or cannibalized its offline sales. They find cannibalization, though it was modest, on the order of 3 percent of the firm's offline sales. Given that brick-and-mortar record stores have clearly suffered from online competition since this study, their result suggests that much of the devastation was sourced in across-firm substitution rather than within-firm cannibalization.

5.2. Online and Offline Channels Linked Through Technological Complementarities

Wang (2007) ties the online and offline channels with a general complementarity in the profit function that he interprets as a technological complementarity. His model treats the introduction of e-commerce into an industry as the opening of a new market segment with lower 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 sketch of the trajectory of the online sector of many retail and service markets. The online leaders were often pure-play sellers: Amazon, E-Trade, Hotmail, pets.com, and boo.com, for example. But many of these online leaders either eventually 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.

Jones (2010) explores a different potential complementarity. The notion is that the online technology is not just a way to sell product, but it can also be an information gathering tool. Specifically, the wealth of data generated from online sales could help firms market certain products to individuals much more efficiently and lead to increased sales in both channels.

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 unusual that these pricing constraints are 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 remark 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 uniform price requirement across channels. An incumbent moving into the online channel is restricted in its

ability to compete on price, because any competition-driven price decrease in the online market reduces what the incumbent earns on its inframarginal offline units. This limit 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. The link across the online and offline channels in this model 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; we expect the insights drawn from this literature to only become more salient in the future. Online channels have yet to fully establish themselves in some markets and, in those 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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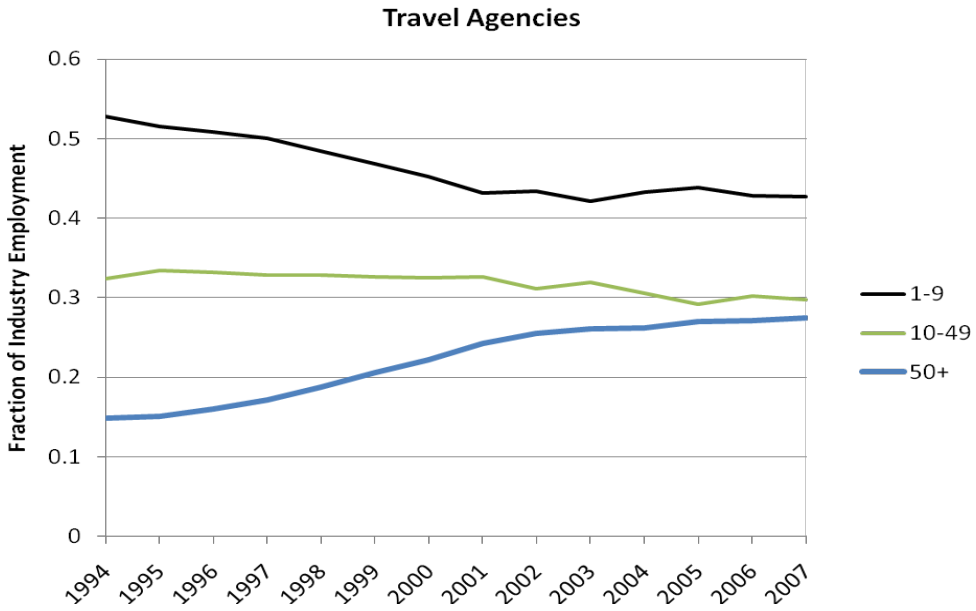
Figure 1. Estimated Share of Industry Employment by Establishment Size

Panel A.



Panel B.

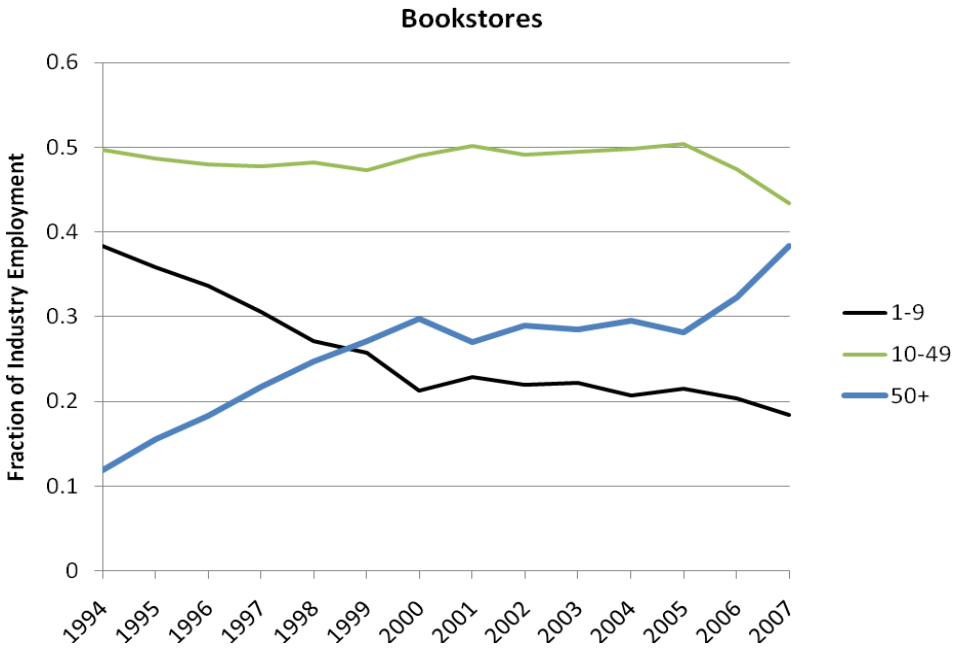
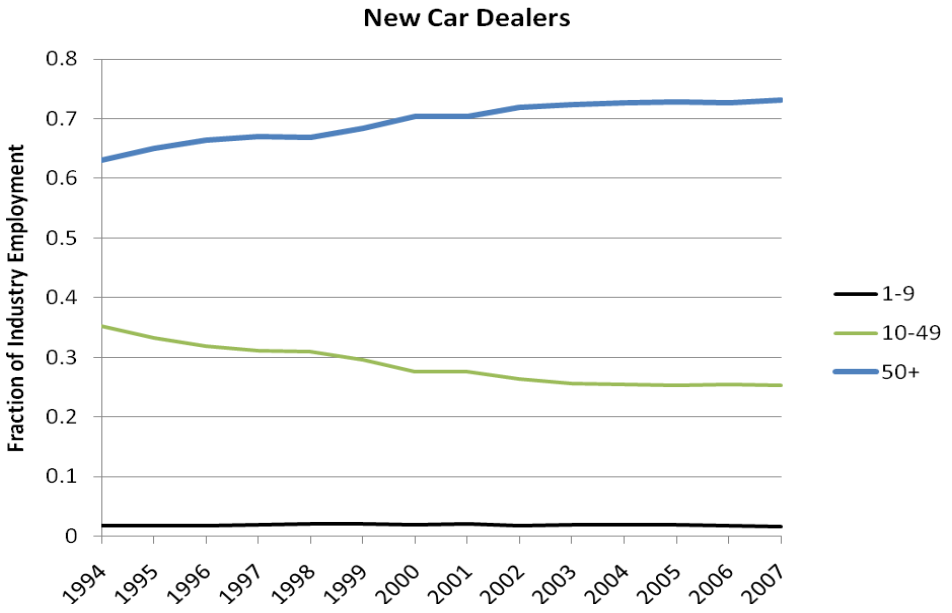
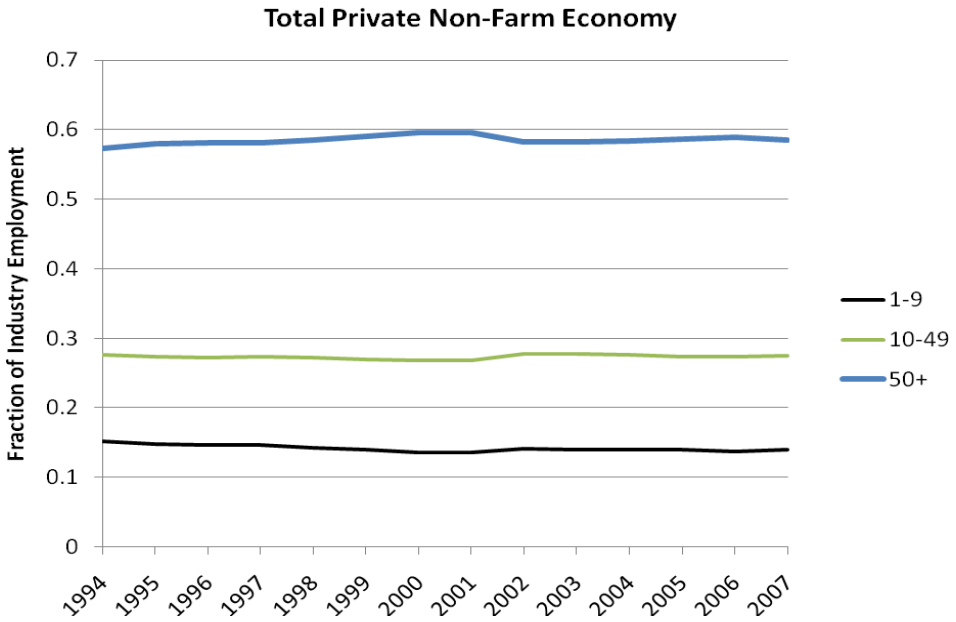


Figure 1 (cont.). Estimated Share of Industry Employment by Establishment Size

Panel C.



Panel D.



Notes: These figures show the fraction of industry or sector employment accounted for by establishments of differing employment levels. Values are taken from the U.S. County Business Patterns data base (available at http://www.census.gov/econ/cbp/index.html). Industry definitions are as follows: travel agencies, SIC 4724/NAICS 561510; bookstores, SIC 5942/NAICS 451211; and new auto dealers, SIC 5510/NAICS 441110.

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

		2002	2008	Percent gain, 2002-2008
Manufacturing	E-commerce	751.99	2154.48	186.5
	Offline	3168.65	3331.78	5.2
	Fraction e-commerce	0.192	0.393	
Wholesale	E-commerce	806.59	1262.37	56.5
	Offline	3345.01	4853.79	45.1
	Fraction e-commerce	0.194	0.206	
Retail	E-commerce	44.93	141.89	215.8
	Offline	3089.40	3817.27	23.6
	Fraction e-commerce	0.014	0.036	
Service	E-commerce	59.97	146.49	144.3
	Offline	4841.03	6700.97	38.4
	Fraction e-commerce	0.012	0.021	
Total	E-commerce	1,663.47	3,705.23	122.7
	Offline	14,444.09	18,703.81	29.5
	Fraction e-commerce	0.103	0.165	

Notes: This table shows the composition of sector sales by e-commerce status. Data are from the U.S. Census E-commerce Reports (available at <http://www.census.gov/econ/estats/>). See text for definition of e-commerce sales.

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: This table shows the estimates from probit regressions of indicators for households using the internet and making purchases online on household demographics. The sample includes U.S. households in the 2005 Forrester Research Technographics survey.

Table 3. Probability of Purchasing Financial Products Online

		Financial Products	
	Any product	Unconditional	Conditional on purchase
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: Estimates from probit regressions of household purchase indicators on demographics. Column 1 reprints for comparison column 2 of Table 2. Columns 2 and 3 use an indicator for whether the household purchased one or more of a set of financial products (see text for list) online in the previous year. Column 2 uses the entire sample; column 3 conditions on the subsample that reports having researched financial products online. The sample includes U.S. households in the 2005 Forrester Research Technographics survey.

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 table reports both levels of and changes in the fraction of households reporting purchasing specific goods and services online. The sample includes U.S. households in the 2002 and 2007 Forrester Research Technographics surveys.

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

	Total online only businesses	Online only businesses 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 table shows the results from regressing the number of online sales businesses (NAICS 45411, Electronic Shopping and Mail-Order Houses) in a geographic market area (see text for definition) on the fraction of consumers in that area that report making online purchases. The sample is an annual panel constructed using establishment counts from U.S. County Business Patterns data and online purchase data from Forrester Research's Technographics Survey. All specifications also include logged total market employment in the year and market fixed effects. 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	Loyals/Switchers
Amazon	0.201	0.203	0.990
Barnes & Noble	0.279	0.278	1.004
Borders	0.087	0.153	0.569
	Consumers Who Purchased Books Online in Past Three Months		
	Loyals	Switchers	Loyals/Switchers
Amazon	0.343	0.262	1.309
Barnes & Noble	0.179	0.274	0.653
Borders	0.034	0.095	0.358

Notes: Entries under “Loyals” are the fraction of customers who purchased from only one of the three firms listed, while “Switchers” are the fraction purchasing from more than one of the three firms. The third column gives the ratio of Loyals to Switchers 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. Data are from Forrester Research’s Technographics Survey.