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Prices and Price Dispersion in Online and Offline Markets for Contact Lenses

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Abstract: Several models predict that margins and price dispersion are negatively related to consumers' information about the firms' prices. This paper adds to the literature studying the effect of search costs on pricing by comparing online and offline prices of disposable contact lenses. Beginning in the late 1980s, technological improvements have eliminated the need for individual fitting of lenses and subsequently have transformed contact lenses of the same brand and prescription into commodities. During the same time, in response to the ability to unbundle lens sales from a contact lens examination, an array of merchants – including optical chains, independent eye care practitioners (ECPs), warehouse clubs, mass merchandisers, and online vendors – now sell contact lenses. Contacts lenses differ from other commodity goods that have been the subject of similar studies in that a high proportion of those who shop at offline stores are unlikely to have shopped online, thus justifying the assumption that online and offline markets are separate. Consistent with competition among online firms being more intense, online prices for a sample of the prices of the most popular disposable lenses are significantly less dispersed than offline prices. I also find that on average offline prices are around 11 percent higher than online prices when controlling for business model differences that are likely to be associated with higher offline costs. These results are robust to weighting by a proxy for shares and various assumptions of shipping & handling costs and offline travel (including time) costs. Also in line with search theory, I find the difference between online and offline prices and price dispersion is relatively low for lenses that are advertised. These results suggest that contact lens consumers still are relatively uninformed about their options and that state laws that impede online sellers of contact lenses are likely to harm consumers.

* Assistant Director, Office of Policy Planning, Federal Trade Commission. The views expressed herein are the author's own and do not purport to represent the views of the Federal Trade Commission or any Commissioner. I would like to thank Rick Geddes, Dan Hosken, John Yun, and two anonymous referees from the FTC Working Papers series for valuable comments. I also thank Zach Mabel for research assistance.

1. Introduction

Due to the difficulty involved with creating standardized lenses, eye care professionals (ECPs) previously had to fit each pair of contact lenses a patient purchased, leading consumers almost invariably to purchase eye exams and contacts in a bundle from their ECP. Beginning in the late 1980s, however, technological improvements have eliminated the need for lenses to be fitted individually and subsequently have transformed contact lenses of the same brand and prescription into commodities.[1] Now, a consumer with a valid prescription can purchase contact lenses from an array of merchants, including optical chains, independent ECPs, warehouse clubs, mass merchandisers, and online vendors.

Contact lens consumers may have more sellers to choose from today than they did ten years ago, but a variety of factors likely have caused many consumers to remain unaware of their full range of options beyond their prescribing ECP. For example, it was not until 2004, when Congress passed the Fairness to Contact Lens Consumers Act (FCLCA)[2] – which prohibits ECPs from tying contact lens sales to eye examinations and requires ECPs to release their patients' prescriptions – that prescribing ECPs in all states were required to release contact lens prescriptions to their patients. Prior to FCLCA, several states' laws made it difficult for consumers to receive a copy of their contact lens prescription, which is necessary to purchase lenses from someone other than a

[1] Contact lenses – like books and CDs – are differentiated products and specific brands compete against one another. Once a consumer has been prescribed a certain brand of lens, however, that lens can be treated as a commodity because it is the same regardless of where it is purchased. For example, a Focus Toric lens of a certain prescription is identical at every location it is sold; a consumer will treat the lens as a commodity, and if retailers are undifferentiated as well, she will be purchase the lens from the seller with the lowest price.

[2] 15 U.S.C. § 7601; 16 C.F.R. § 315.3.

prescribing ECP.[3] Further, there is anecdotal evidence that prescribing ECPs are hesitant to let their patients know that their prescriptions are portable (*See* 1-800 Contacts 2005b, pp. 18-30), and the FTC, which is in charge of enforcing the prescription release requirements of FCLCA, recently reported violations involving prescribing ECPs not releasing prescriptions to their patients.[4]

When consumers do not know the distribution of prices and have difficulty determining what individual merchants charge, they are more likely to purchase from the first store they visit, which, in the case of contact lenses, always will be their prescribing ECP.[5] Given the relative youth of the replacement contact lens market, state regulatory impediments, lack of consumer knowledge of their right to their prescription, and reported historical reluctance on the part of some prescribers to release prescriptions, it is probably reasonable to assume that many contact lens consumers do not routinely search for prices lower than the one their prescribing ECP offers. It should not be surprising that data indicate substantial inertia toward purchasing from prescribing ECPs; independent ECPs perform over 60 percent of all adult eye examinations and, despite charging the highest prices of any retail channel, sell a similar proportion of all contact lenses. Because all prescribing ECPs by necessity are associated only with offline sellers, it is

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[3] *See*, *e.g.*, *Hardy v. City Optical, Inc.*, 39 F.3d 765 (7th Cir. 1994), a case in which an ECP claimed that Indiana law prevented him from releasing contact lens prescriptions to patients who wanted to purchase lenses at cheaper outlets. Additionally, FTC (2004, p.23-25) discusses anecdotal evidence that even in states that explicitly allowed prescription release before FCLCA, some prescribers refused to release contact lens prescriptions to their patients.

[4] *See* FYI on The Contact Lens Rule and the Eyeglass Rule (Oct. 24, 2004) *at* http://www.ftc.gov/opa/2004/10/contactlens.htm.

[5] This is because the decision to engage in additional search is a positive function of the probability of finding a lower price. If costs of search are high, the expected benefit from additional search (savings*probability a lower price is found) must be sufficiently high to justify additional search. If a consumer over-estimates the lower bound of the price distribution, she necessarily will under-estimate the probability of find a lower price with additional search.

likely that a large proportion of those who purchase offline never shop online for their lenses.

This paper shows, however, that if consumers shopped for lenses online, they could save substantially. It is reasonable to assume that the Internet allows consumers to compare competing online merchants' prices more cheaply than they can those offered by offline stores. Visiting an online merchant's Web site to find a price almost certainly takes less time than visiting or even calling an offline merchant for the same information. Additionally, "shopbot" Web sites like Shopping.com or BizRate.com allow consumers to compare large numbers of online competitors' prices with the click of a mouse. I find evidence that the relative ease with which consumers can compare prices offered by competing online outlets has led online sellers to compete on price more intensely than their offline counterparts, leading to lower online prices.

In most models of consumer search, given search costs and knowledge of the price distribution, a consumer determines how many stores to visit and purchases from the lowest price firm observed; he will visit an additional store only if the expected gain (from a price lower than the lowest one observed to date) is greater than the cost of search.[6] When consumers face no costs to obtain an additional price quote, stores must set their prices on the assumption that anyone visiting their store already knows – or will soon discover – the lowest price offered. Accordingly, in the case of homogeneous goods, all stores must meet the lowest price offered or make no sales. When consumers face positive search costs, they will visit fewer stores, which in turn increases the probability that a given store's price will be the lowest that a consumer will observe

[6] *See* Stahl (1989); Burdett & Judd (1983); Carlson & McAfee (1983); Salop & Stiglitz (1976).

during his search. Because high search costs reduce competitive pressures, it follows that margins and price dispersion are negatively related to consumers' information about firms' prices.[7]

Due to the low cost of comparing online prices, by contrast with its offline counterparts, an online seller rationally may expect that almost all of its patrons have visited – or will visit – a large proportion of its online competitors. The online firm, then, must set its prices on the assumption that anyone visiting its Website has seen the lowest online price offered. Accordingly, we would expect to see online prices for homogeneous goods to be lower and less dispersed than those offline; indeed, in the limiting case where all online consumers are perfectly informed about competitors' prices and view all online vendors as perfect substitutes, a zero-profit Bertrand equilibrium obtains.[8]

I examine a sample of the prices online and offline sellers charge for some of the most popular disposable lenses. Overall, the data indicate that search costs play an important role in stores' pricing decisions. Consistent with competition among online firms being more intense, online prices are significantly less dispersed than offline prices. This result is robust to weighting for shares and controlling for interstore heterogeneity

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[7] Several economists have found empirical support for this prediction by identifying proxies for consumers' knowledge of price distributions. Dahlby & West (1986), for example, examine insurance premiums in Canada and find evidence that prices are less dispersed for the driver classes that are most likely to comparison shop. Van Hoomiseen (1988) posits that inflation acts to reduce consumer information on relative prices, and finds a positive relationship between inflation in Israel and price dispersion. Most recently, Sorensen (2000) uses the fact that consumers are likely to have the strongest incentives to search for low prices for frequently-purchased prescription drugs (i.e., those that treat chronic conditions) to fashion an empirical test. Consistent with consumer search theory, he finds that both average prices and price dispersion are higher for one-time prescriptions compared to drugs that are purchased monthly.

[8] *See* Bakos (1997) who catalogues several claims by commentators has to how the internet would bring about "frictionless" markets, where prices are driven to marginal cost.

by examining the interstore variance of the residual from a regression of lens price on store and lens-fixed effects.

I also study differences in online and offline prices, but unlike previous studies, I take advantage of the variation in offline business models to control for factors that are likely to be associated with higher offline costs. I find that when these business model differences are taken into account, offline prices are on average 11 percent higher than online prices. When shipping & handling costs and offline travel costs – including time costs – are added to list prices, offline prices are between 7 and 19 percent higher than offline prices, depending on how offline travel costs are allocated. This is important, because some previous results have been sensitive to assumptions about weighting and costs associated with getting the good to the consumer (or the consumer to the good). Further, to my knowledge, this is the first study of online and offline prices explicitly to account for consumer time costs.

In contrast to the other lenses in the sample, competing sellers often advertise the prices they charge for Acuvue lenses. Because it is likely to be more costly for consumers of non-Acuvue lenses to determine the prices charged by competing offline sellers than for Acuvue wearers, online markets are likely to have less of an impact on the pricing for Acuvue brand lenses than other lenses (*see*, *e.g.*, Kwoka 1983; Feldman & Begun 1978; Benham 1972). I take advantage of the variation in consumer knowledge of lens prices and use Acuvue brand lenses as a control group in a difference-in-difference approach to measuring the effect of Internet availability on online and offline price dispersion and levels. Consistent with search costs influencing pricing, I find that the ability to comparison shop more cheaply online has had a much smaller impact on the prices of advertised lenses.

Although the data are consistent with online markets functioning more efficiently than their offline counterparts, like other studies of online pricing, I find that the online market for contact lenses still exhibits levels of dispersion greater than what we would expect to see in Bertrand competition. Specifically, a consumer could save up to 37 percent off the average price of lenses online by finding the lowest online price. Consistent with earlier research, I also find evidence that differences among online firms related to consumers' trust that a transaction will take place without a hitch is an important source of online price dispersion.[9]

Not surprisingly, many economists have identified the online-offline dichotomy as fertile ground to test the predicted relationship between consumer search costs, price levels, and price dispersion. The empirical work in this area, which largely compares online and offline prices of books and CDs (*see*, *e.g*., Clay et al. 2002; Brynjolfsson and Smith 2000; Lee and Gosain 2002; Bailey 1998), has arrived at no consensus that online

[9] Economists examining this issue have found evidence that brand names that provide an assurance that an online transaction will be completed without a hitch are the most important dimension of online differentiation. At least three studies examine the role of differentiation in explaining online price dispersion. Using hedonic regression techniques similar to Sorensen (2000), Pan et al. (2002) find that for a range of goods, differentiation—as measured by BizRate.com consumer ratings—does not go very far in explaining online price dispersion. Clay et al. (2002) use Web site attributes and store-specific dummy variables to control for store level differentiation. They find attributes have little explanatory power compared to store-specific effects and interpret this result as indicating that stores follow pricing or branding strategies that are uncorrelated with their Web sites' attributes. Smith and Brynjolfsson (2001) find that even when consumers use shopbots to compare the prices of identical books from a variety of online sellers, they are willing to pay a $2.49 premium to purchase from a well-known online merchant like Amazon.com. This result also is similar to Brynfolfsson & Smith's (2000) earlier finding that heavily-branded online retailers rather than the ones with the lowest prices enjoy the largest shares. Clay et al. (2002) did not control for branding. Although Pan et al. (2002) control for some elements that would be associated with a consumer's belief that a transaction would be completed as expected (the "reliability" variable in their hedonic regressions), they use ex post consumer survey information that consumers in general are unlikely to consult before making a purchasing decision.

prices are lower or less dispersed than offline prices.[10] Further, and perhaps not unexpectedly, no studies have found levels of online price dispersion at levels low enough to suggest online firms selling homogenous goods are Bertrand competitors (*see*, *e.g*., Brynjolfsson and Smith 2000; Clay, Krishnan, and Wolff (CKW) 2001; Clay et al. 2002; Clemons, Hann, and Hitt 2002).

One assumption implicit in this literature is that offline stores set prices based on expectations of their patrons' knowledge of other offline firms' prices, not online prices. That is, most of those who shop at Barnes & Noble base their purchase decision on their knowledge of Borders', Crown's, and Wal-Mart's prices for the same book, not on Amazon.com's price. It is more expensive to compare among offline than online firms. But, for those consumers with Internet access, comparing an offline price to an online price should be no more expensive than comparing among offline firms. Once online, moreover, it is extraordinarily cheap to gain additional price quotes from online merchants. For instance, if a consumer with Internet access already knows the price that Borders charges for a particular CD, it appears that it would be equally costly to phone Barnes & Noble for a price quote or to go online and search several merchant's prices.

Thus, there is no *a priori* reason to believe that – apart from those consumers who either do not have Internet access or who are unwilling to purchase goods online due to

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[10] For example, in an early examination of the issue, Bailey (1998) finds books, CDs, and software to be significantly more expensive and prices to be more dispersed online. Clay et al. (2002) examine offline and online prices for best sellers and niche books and find similar results when taxes are added to offline purchases and shipping & handling costs are added to online purchases. They do not weight observations by share or add transportation costs to online prices. Alternatively, in a careful study that samples prices over several months and geographic regions Brynjolfsson and Smith (2000) find online prices for popular and niche books and CDs to be lower and less dispersed than their offline counterparts. This result holds regardless of whether transportation and shipping & handling costs are added, or whether online prices are weighted by share. *See* Ellison and Ellison (2005) and Elberse et al. (2002) for thorough reviews of the relevant literature. A related literature examines how the Internet has affected the prices of offline goods. *See*, *e.g*., Brown and Goolsbee (2002). Scott-Morton, Zettelmeyer, and Silva-Risso (2001). Goolsebee (2002) examines the extent to which online prices affect offline prices for computers.

idiosyncratic reasons – a large proportion of those purchasing offline have not searched online as well; most of those who ultimately purchase offline may have no less knowledge of online prices than those who end up purchasing from an online store. If this is the case, offline sellers of books and CDs are likely to take into account online pricing when setting their prices. This may be one reason why studies of these goods have arrived at no consensus that online and offline prices are statistically different.

Due to the reasons discussed at the outset of this paper, in contrast to goods previously studied, offline sellers of contact lenses are likely to face a large number of customers who are unaware of online pricing. Because the assumption that the markets are separable is more likely to hold in the case of contact lenses than in other goods, these data are likely to provide a cleaner test of the lower search cost hypothesis.

The remainder of this paper is organized as follows. Section 2 provides a brief overview of the contact lens industry. Section 3 describes the data and Section 4 presents the main results. Section 5 discusses some implications of these results and concludes.

2. Overview of the Contact Lens Industry

When contact lenses first were introduced, they were made of rigid material that required an ECP to custom fit each pair. In 1971, the FDA approved the first soft contact lenses. Still, at this early stage of development, soft lenses were manufactured in a way that did not always accurately reproduce the original prescription. These early lenses were designed to last for long periods, so consumers generally purchased lens from their ECP after an exam and replaced them infrequently.

The evolution in contact lens technology now allows the sale of lenses to be unbundled from the fitting exam.[11] Technological improvements have solved standardization problems, eliminating the need for an ECP to fit each replacement pair once the prescription has been finalized at the end of the fitting process; the replacement lens a consumer purchases pursuant to a prescription that specifies a brand will be identical, regardless of whether the patient receives this lens from the prescribing ECP or from another seller. FCLCA mandates that a contact lens prescription typically must last at least one year. Because consumers usually purchase less than a year's supply at a time, most contact lens consumers will purchase replacement lenses at least once during the length of their prescription. [12]

Recent data indicate that 36 million Americans—almost 13 percent of the population—wear contact lenses (FTC 2005). According to Census Bureau (2004) data U.S. shipments of all contact lenses were valued at $1.9 billion in 2002,[13] and estimates place annual U.S. soft contact lens sales somewhere between $1.4 and $1.8 billion.[14]

Contact lenses are classified in two major categories—spherical and specialty. Spherical lenses contain a single refractive power and are by far the most commonly prescribed lens. Varieties of specialty lenses include toric (to correct astigmatism),

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[11] The current contact lens fitting process includes an examination to determine eye health, lens power, and contact lens curvature and diameter. ECPs use a "fitting set," or a sample pair of contact lenses, as a diagnostic tool to determine whether the prescription is correct. A follow-up appointment in 7-10 days to assure visual acuity, fit, and comfort is typical.

[12] 15 U.S.C. § 7604(a).

[13] This estimate is consistent with private research, which projected U.S. sales of contact lenses in 2003 to reach $1.92 billion, or 11.8% of total U.S. retail optical sales. *See The State of The Optical Market*, 20/20 MAGAZINE (2003), *at* http://www.2020mag.com/index.asp?page=3_190.htm; Jobson Optical Research, *The State of the Optical Market*, 2nd Quarter, 2003, *at* http://optistock.com/jobson-som-2003-06.pdf. The same data estimate sales of prescription lenses and frames to account for 84.2% of total U.S. retail optical retail sales in 2003, and that eye examinations generated $3.6 billion in revenues in 2002.

[14] CooperVision (2003) reports that total U.S. sales of soft lenses are $1.4 billion. The 2002 Census data lists U.S. soft contact lens sales at $1.8 billion.

multifocal (to correct near and far-sightedness simultaneously), cosmetic tint, and extended wear. According to industry data, spherical lenses accounted for 70 percent of dispensing visits and 57 percent of total soft lens sales in 2003.[15] Within the specialty segment in 2003, toric, cosmetic tint, and multifocal lenses accounted respectively for 16 percent, 9 percent, and 5 percent of patient visits when contacts lenses were dispensed.[16] Most consumers wear lenses that are taken out every night and disposed of according to a replacement schedule. Lenses requiring replacement every two weeks are the most popular option, followed by lenses that are replaced on a monthly basis.[17]

There are four major contact lens manufacturers (Bausch & Lomb, CooperVision/Ocular Sciences,[18] Ciba Vision, and Vistakon), and contact lenses are sold to consumers through several outlets. According to public data, independent ECPs (both optometrists and ophthalmologists) accounted for approximately 68 percent of sales, with the remaining offline channels, such as optical chains, mass merchandisers, warehouse clubs, accounting for between 18 and 25 percent of sales. *See* FTC (2005, at 11). The same data has online and mail order outlets accounting for between 8 and 13 percent of sales.

3. Data

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[15] Optistock (2003) reports that clear spherical accounted for approximately 70% of patient visits where a lens was dispensed for the first three quarters of 2003). Similarly, CooperVision (2003, p.21) notes that specialty lenses account for 43 percent of U.S. soft lens market sales. The disparity in data for sales and lenses dispensed may reflect the fact that specialty lenses typically are more expensive than spherical lenses.

[16] *Id.*

[17] Optistock (2003) reports that for first three quarters of 2003, two-week and monthly replacement lenses account for 64% and 20% of new contact lens fits, respectively. FTN Midwest Research (2004, p.7) reports that 62% and 22% of ECPs surveyed responded that two-week and monthly disposables were the most common lenses prescribed, respectively).

[18] CooperVision recently acquired Ocular Sciences.

During the week of November 29 – December 5, 2004, price information was collected for a six-month supply of ten of the most widely-worn contact lenses from 20 online and 14 offline retailers. A six-month supply was chosen based on public data that suggest this to be the most commonly purchased quantity of lenses.[19] Six spherical lenses (Acuvue, Acuvue2, Acuvue Advance, Frequency55, Biomedics55, Proclear Compatable), three toric lenses (Frequency55 Toric, Softlens66 Toric, Focus Toric), and one multifocal lens (Softlens Multifocal) were selected for the study. The mixture of spherical and specialty lenses is roughly consistent with consumer purchasing patterns.

No publicly available data exists on market shares of individual lenses, but the lenses sampled were chosen to be among the most frequently purchased and are thus likely to capture a large proportion of actual consumer purchasing patterns. For example, Vistakon is the leading contact lens manufacturer and its Acuvue brand contact lenses are the world's leading selling brand of spherical lens.[20] Additionally, Proclear Compatibles, Biomedics55, and Frequency55 are the leading brands of CooperVision, which due to its recent acquisition of Ocular Sciences is among the top four contact lens sellers in terms of sales.[21] Trade press and company reports suggest that CooperVision, Bausch & Lomb, and Ciba Vision account for the most of toric lens prescriptions, thus the inclusion of CooperVision's Frequency55 Toric, CibaVision's Focus Toric, and Bausch & Lomb's Softlens66 Toric are likely to capture a large proportion of actual consumer purchases of

[19] According to this data, in 2004, surveyed ECPs reported that after the exam 64% of patients purchased a six-month supply, 20% purchased a year's supply, and 6% purchased a three-month supply. Additional data provided to the FTC also suggests that consumers purchase less than a year's supply of contact lenses, showing that only 12% of consumers from a national survey purchased a year's supply at once, whereas 31% purchased lenses two times a year, and 43% purchased 3 - 4 times a year. *See* FTC (2005, pp. 5-6)

[20] *See* Vistakon's website statement at http://www.jnjvision.com/about_vistakon.htm; OSI (2004, p. 6).

[21] *See* CooperVision (2003). OSI (2004, p. 29) refers to its Biomedics brand as its "flagship product."

toric lenses.[22] Finally, Bausch & Lomb's Softlens Multifocal is the leading multifocal lens.[23]

Of the online retailers (listed in the first column of Table 1), 16 are pure online sellers—those with no offline presence—and 4 are hybrids, meaning that they have both online and offline sales. Pure online sellers were selected based on the results of a search for "contact lenses" at shopping.com, a price comparison search engine.[24] Hybrid sellers were selected by determining whether well-known offline outlets also had a Web site.

The offline retailers sampled (listed in the second column of Table 1) were all located in the Northern Virginia Area (primarily Alexandria and Arlington) and fell into one of four channels: wholesale clubs, mass merchandisers, optical chains, and independent ECPs. Sam's and BJ's were sampled to represent wholesale clubs and Target and Wal-Mart were sampled to represent mass merchandisers. With the exception of Costco, which would not give price quotations for contact lenses over the phone, the sample of mass merchandisers and wholesale clubs is likely to comprise almost the entire population for the geographic area.[25] LensCrafters, Pearle Vision, Hour Eyes, and Sears Optical were sampled to represent optical chains.

The independent ECPs in the sample were chosen by first searching for "optometrists" in the Yahoo yellow pages for the zip code 22301 (Alexandria, Virginia), which produced a list of 21 independent ECPs. To assure reliability, this list was cross-referenced with another list of independent ECPs from the area to arrive at 13 ECPs who

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[22] Bausch & Lomb (2003, p. 2); FTN Midwest Research (2004, p.10); Optistock (2003, p.3).

[23] *See* Bausch & Lomb Annual Report; FTN Midwest Research (2004).

[24] This methodology for determining a sample of online merchants has been employed by Clay *et al*. (2002), Zoonky and Gosain (2002), Clay *et al*. (2001); Brynjolfsson and Smith (2000).

[25] Although K-Mart would be another potential mass merchandiser competitor to Wal-Mart and Target, according to K-Mart's Web site it does not offer optical services at its local stores.

appeared on both lists. From this list, six were chosen at random. Although resource constraints prevented sampling a greater number of optical chains and independent ECPs, the sample is likely to be representative of the population. For example, each of the optical chains sampled belong to one of the two largest grossing optical retailing groups (Luxottica and Eye Care Centers of America).[26] Further, the sample is likely to include a substantial proportion of the largest independent ECP practices in the market area.

For online merchants, researchers visited each Web site and gathered the price of each lens and the standard shipping option. Researchers posing as potential customers collected prices quotes from offline merchants over the phone.[27] For every outlet sampled, researchers collected information on manufacturer and retailer rebates. No online site offered rebates on a six-month supply of lenses (most rebate offers only cover a year's supply of lenses), and very few offline merchants offered rebates.[28] Because it is unclear whether the clerks surveyed at these stores were providing accurate information regarding rebates on six-month supplies or how frequently consumers follow-through with mail-in rebates, rebate information is not included in the data.

As seen in Table 1, almost all outlets carried at least 80 percent of the lenses in the sample. A store reported a lens as unavailable in only 8.5 percent of the potential 340 observations, leaving a total of 311 observations. Online and offline stores carried on average 88.5 percent and 95.7 percent of the lenses studied, respectively. Taken as a whole, online and offline availability are approximately equal. A majority of online and

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[26] *See* FTC (2005, p. 10).

[27] Virginia does not tax contact lens sales to consumers.

[28] Specifically, Wal-Mart offered manufacturer rebates on five spherical lenses ranging from $12-15, Target offered a retailer rebate ranging from $15.99 to $19.96 on three different lenses, and LensCrafters offered an $8.80 rebate on one lens.

offline stores carried all lenses (55 and 57 percent, respectively). The lower offline average is reflective of very low carriage rates from two sellers; when these two sellers are dropped from the sample, the average percentage of lenses carried by online retailers rises to 93.9 percent. Further, if hybrid Web sites are eliminated from the sample to focus on only pure online merchants, the average percentage of lenses carried rises to 97.9 percent. More of the missing observations are for CooperVision's Proclear Compatible lens than any other lens, presumably because the manufacturer has a policy to limit this lens' distribution.

Table 2 presents summary statistics of price information collected. For online observations, prices that include shipping and handling are presented in parentheses. Online prices for all lens types are less than offline prices taken together, but warehouse clubs offer the lowest average prices of any channel. Further, hybrid pricing is substantially higher than that for pure online merchants. In fact, a closer examination of the data reveals that with the exception of Wal-Mart online, hybrid sites' pricing reflects the pricing of their offline counterparts. Accordingly, comparisons of online and offline channels for the remainder of the paper focus only on pure online merchants.

4. Empirical Results

4.1 Price Dispersion

As discussed above, one hypothesis that follows from search theory is that prices should be less dispersed online than offline. Table 3 presents various measures of online and offline price dispersion (standard deviation, coefficient of variation, range, and range as a percentage of the average price).[29] All measures of dispersion are calculated at the individual lens level and then averaged across lenses.[30] Overall, offline prices are about twice as dispersed as online prices, and using a Wilcoxon rank-sign test, all differences are significant at standard levels.[31] For example, the average range of offline prices is $67.32 compared to $33.33 online and the average offline standard deviation is $19.77 compared with $8.53 online. This suggests that a consumer shopping offline could save almost twice as much by seeking out the lowest-price outlet as someone shopping online.

Because consumer purchases are not uniformly distributed across outlets, giving each price observation equal weight may distort comparisons of online and offline prices. For example, if consumers tend to purchase more from relatively higher (lower) priced outlets, equal weighting will tend to bias average prices downward (upward). Further, if outlets that charge outlier prices receive little business, equal weighting will overstate price dispersion. To remedy this potential problem, I construct weights for online and offline observations that proxy for shares of sales.[32]

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[29] Because online firms can compete on shipping costs but offline firms can compete with regard to proximity to consumers only in the long run, I include shipping and handling costs in online merchants' prices, but do not include transportation costs for offline stores.

[30] *See* Appendix for details of how dispersion measures are calculated.

[31] Given the relatively small sample for these comparisons (N=20) and doubt that the small-sample distribution of these variables justifies normality assumptions, I used the non-parametric Wilcoxon rank-sign test. An F-test for equality of variances for each lens (not reported) shows that online prices for all but two lenses (Proclear and Softlens 66 Toric) are statistically significantly more dispersed than offline prices for the same lenses.

[32] There is no publicly available information on online shares, but data indicate that online contact lens sales are around $200 million. Using this as a denominator, I calculated online shares for 1-800 Contacts, Vision Direct, and Coastal Contact from publicly available revenue information ($93.5 million, $40 million, and $28 million, respectively). I divided the remaining 19 percent equally among the remaining 13 online firms for which no revenue information is available. With regard to offline weighting, again there is no publicly available share information for specific outlets, but public data provided to the FTC indicate the following shares of total offline sales for each offline channel: 74.4 percent for ECPs; 10.4 percent for optical chains; and 15.2 percent for mass merchandisers and warehouse clubs combined. I construct weights for each outlet sampled by dividing channel shares equally among all firms within a channel. As a result of this process, each independent ECP is assigned a 12.4 percent share of offline purchases, each

As seen in Table 4, weighting observations by a proxy for share does not significantly alter either online or offline price dispersion, and differences remain statistically significant. It also is important to note that the relatively larger level of price dispersion offline is not driven by the inclusion of warehouse clubs in the sample. The third columns of Tables 3 and 4 show that although excluding warehouse clubs from the offline sample does reduce offline standard deviation and range, online dispersion is still less than offline dispersion, and that these differences remain mostly significant.

Because online and offline channels differ significantly in a variety of important ways, one cannot ignore the role that factors beyond search costs may be playing in the data. Most significantly, offline stores clearly are more differentiated than their offline counterparts. Although disposable contacts of the same brand and prescription are themselves identical regardless of where a consumer purchases them, there are likely to be differences in service and convenience among offline outlets. For example, if the wait is longer and the staff less knowledgeable at a warehouse club than an independent ECP's office, some consumers may be willing to pay more for the same contacts at the latter outlet. Further, bricks-and-mortar merchants are geographically dispersed and utilize a wide array of business models; independent ECPs and optical chains operate in professional offices and malls and specialize in selling optical goods, while mass merchandisers and warehouse clubs operate in large free-standing stores in which optical goods comprise only a tiny proportion of all sales. Online sellers' business models, by

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optical chain outlet is assigned a 2.6 percent share of offline purchases, and each warehouse club and retail outlet is assigned a 3.8 percent share of offline purchases.

contrast, are relatively homogeneous and all share the same "location" from consumers' perspectives.[33]

Table 5 indicates that offline stores are more easily categorized into high or low-priced outlets than online outlets. For example, the warehouse clubs sampled offered one of the four lowest prices for 90 percent and 70 percent of the lenses, respectively, and independent ECPs and optical chains appear consistently to charge among the highest prices for the lenses sampled. Although three online firms appear consistently to offer among the highest online prices (1-800 Contacts, LensesforLess, and 1-Save-on-Lens) and two appear to offer among the lowest online prices on most lenses (Coastal Contacts and Contact Lens Discount), the overall pattern of pricing from Table 5 suggests that online firms are not as easily classified into high and low-price outlets as their offline counterparts. Thus, it seems plausible that at least some proportion of offline price dispersion is a result of relatively more differentiated stores rather than higher search costs.

To control for heterogeneity across outlets that may be driving price dispersion, I regressed lens price on store and lens-fixed effects:[34]

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[33] Several studies comparing online and offline pricing of books and CDs have found online price dispersion and price levels to be at least as large as that offline. It is likely to be the case, however, that offline book and CD sellers sampled in those studies are less-differentiated than offline contact lens sellers. For instance Clay et al. (2002) collect offline book prices from stores with similar business models (Barnes & Noble and Borders) and Lee & Gosain (2002) collect offline CD prices exclusively from stores where record sales comprise a major portion of their business (Barnes & Noble, Borders, Sam Goody, Tower, and Virgin). Bynjolffson and Smith (2001) have a slightly more diverse sample of offline merchants, which Clay et al. (2002) point out may, in part, be driving their price level results because the smaller stores that they sampled tend to have higher prices than larger chains. Further, the more diverse sample also may play a role in the finding of a significant difference between online and offline price dispersion.

[34] As noted earlier, the most important component of online differentiation is likely to be consumers' willingness to trust that a transaction will be completed. Ideally, I would have a direct measure for trust, but store fixed-effects are likely to serve as a good proxy. Pan et al. (2002) and Clay et al. (2002) find that in price regressions proxies for online store attributes have little explanatory power, and Clay et al. specifically find that such proxies have no explanatory power when store fixed-effects are included.

$$p_{ij} = C + \alpha_i + \delta_j + e_{ij}, \qquad (1)$$

where p_{ij} is the price of lens i at outlet j, α_i is a lens fixed effect, and δ_j is a store fixed effect. The goal is for δ_j to sweep away the effects of firm-specific pricing strategies that may be related to idiosyncratic cost or demand parameters. Table 6 shows measures of price dispersion for the residuals from this regression (e_{ij}), which proxy for prices that have been adjusted for interstore differentiation.[35] Consistent with offline firms being more differentiated than their online counterparts, these results suggest that interstore heterogeneity is responsible for almost twice as much of the observed offline dispersion compared to online dispersion. The online standard deviation and range do not differ significantly from those reported in Table 4: $8.40 versus $7.09 and $33.33 versus $30.44, respectively (a decrease of only 17% and 9%). By contrast, controlling for interstore heterogeneity reduces offline standard deviation and range by 30% and 31%, respectively. Even so, after controlling for interfirm differentiation online prices still are statistically significantly less dispersed than their offline counterparts, which suggests that consumers who shop online for contact lenses enjoy lower search costs.[36]

Another method to test whether consumers face lower search costs online is to use the variation in consumer knowledge of prices across lenses. Acuvue brand lenses are the most widely worn, and casual empiricism suggests that they are the most heavily

[35] The R-squared from this regression is 0.90, compared to 0.74 for a regression with only lens-specific effects and 0.81– 0.89 for the price regressions reported in Tables 8-10. This suggests that store-specific effects are an important source of price variance.

[36] To check for whether lens availability affected the results, all dispersion tests also were run on a subset of lenses that were the most widely available (Acuvue2, Biomedics55, Frequency55, Softlens66 Toric, and Frequency55 Toric), defined missing from no more that two merchants (only Softlens66 Toric was available at all outlets). Offline dispersion rises, but results are qualitatively nearly identical.

advertised of those lenses sampled.[37] Because price advertising and word of mouth on what various outlets charge for Acuvue lenses (which is likely to be a positive function of the number of people who purchase Acuvue lenses) reduce consumers' search costs, we would expect consumers to be relatively more informed about the price distribution of Acuvue brand lenses than other brands. If this is the case, the marginal impact of the Internet on consumer search costs should be greater for non-Acuvue than for Acuvue lenses.

The last two panels of Tables 3, 4, and 6 show measures of dispersion for Acuvue and non-Acuvue lenses. First, it is important to note that even for Acuvue lenses online price dispersion is less than that offline. Indeed, that after controlling for interfirm differentiation, measures of dispersion for the most heavily advertised lenses still are larger offline than online, is strong evidence that consumers in online markets for contact lenses enjoy lower search costs. Consistent with the hypothesis that consumers are relatively more informed about the distribution of Acuvue prices, however, intrachannel comparisons reveal that all measures of price dispersion for Acuvue brand lenses are less than non-Acuvue lenses. Because the average price of non-Acuvue lenses is higher than Acuvue lenses, we would expect the range and standard deviation to be larger for the former category. However, even when normalized by average price, these measures are largest for non-Acuvue lenses in both online and offline channels.

A comparison of residual dispersion measures in Table 6 with those in Tables 3 and 4 indicates that differentiation is an important source of dispersion only for non-

[37] For example, an informal sampling of advertisements the Sunday Washington Post during 2005 finds that the price of Acuvue lenses often accompanies circulars from optical stores and other outlets, whereas advertisements for other lenses in the sample are never seen. Further, OSI (2004, p.30) notes that it rarely advertises directly to consumers.

Acuvue lenses sold offline. Controlling for store-specific attributes has a very slight negative effect on measures of dispersion for all online prices and offline prices for Acuvue lenses, but has a much larger negative effect on offline prices for non-Acuvue lenses. This is consistent with purchasers of Acuvue lenses viewing retailers as more fungible than non-Acuvue customers.

This variation in consumer knowledge across lenses can be used to further test the hypothesis that search costs are lower online. Specifically, I use a difference-in-difference approach, with Acuvue prices serving as a control group and non-Acuvue lenses serving as the treatment group to compare online and offline measures of dispersion. I use the data from Tables 3, 4, and 6 to calculate:

$$\Delta = \left(\frac{1}{N_{NAV}} \sum_{i=1}^{N_{NAV}} (d_i^{Off} - d_i^{On}) \right) - \left(\frac{1}{N_{AV}} \sum_{i=1}^{N_{AV}} (d_i^{Off} - d_i^{On}) \right) \qquad (2)$$

where d_i is the relevant measure of dispersion (standard deviation, coefficient of variation, range, and normalized range) for a specific lens and channel, subscripts *NAV* and *AV* denote non-Acuvue and Acuvue brand lenses, respectively, and superscripts *On* and *Off* denote on and offline, respectively. If online and offline consumers are similarly informed about the price distribution in each respective channel for Acuvue lenses, and consumers shopping online for non-Acuvue contact lenses enjoy lower costs for comparing lens prices than those shopping offline, then Δ should be positive.

The results shown in Table 7 are supportive of the lower search cost hypothesis. All measures of Δ are positive and almost half are statistically significant at standard levels using a Wilcoxon rank-sum test.[38] Further, these results are generally robust to weighting and the exclusion of warehouse stores from the offline sample, although differences-in-differences for residual measures are positive, but not significant. Taken as a whole, the results are consistent with search theory: The marginal impact of lower search costs online does appear to be largest for consumers of non-Acuvue lenses.

Although online price dispersion appears to be lower than that offline, the data reveal that it is still more than would be expected in a model of Bertrand competition. Standard deviation as a percentage of average price levels (coefficient of variation) is 0.10 for all lenses and the range of online prices as a percentage of the average online price is 0.37 for all lenses.[39] Further, 1-800 Contacts has the highest share of any online seller but for 70 percent of the lenses sampled, it offered prices that were among the top 4 highest prices offered online. At the same time, two lesser-known sellers with lower shares—Coastal Contacts and Contact Lens Discounts—offer among the lowest prices for all of the lenses sampled. These results are consistent with those of Smith and Bryjolfsson (2001), who find that the most heavily branded online retailers charge higher prices than less well-known online retailers.

These findings suggest that even though contact lenses are themselves homogeneous, consumers may view the package of services that online sellers bundle with the lenses as a differentiated product. Although a casual review of Web sites does

[38] Given the small number of observations the lack of knowledge of small sample distributions of the measures of dispersion, I used the Wilcoxon rank-sum test, which does not rely on distributional assumptions.

[39] These levels of dispersion, in general, are slightly lower, but within the range of those that Clay et al. (2002) and CKW (2002) report for online book prices.

not reveal important differences in the shopping experience among online vendors,[40] one important dimension of differentiation is likely to be trustworthiness, which may be especially important with regard to a medical product like contact lenses. As B&S (2000, p.578) note:

> While the importance of factors such as search costs may be reduced on the Internet, factors such as trust may play an enhanced role because of the spatial and temporal separation between buyer, seller, and the product on the Internet. Most consumers have little history or physical contact with Internet retailers and they must be wary of falling prey to a site that posts low prices but is proficient only in charging credit cards, not delivering the goods.[41]

Thus, consumers may enjoy lower search costs online, but choose to forego lower prices in return for greater assurances that their transaction will be completed without a hitch. This may explain why 1-800 Contacts—the best-known online seller—is able to command higher prices than less-well known sellers.[42]

Another contributing factor to online dispersion is that although price comparisons for contact lenses are easier online than offline, they are not costless. It is likely that consumers are aware of only one or two online contact lens vendors from advertising and may not feel it worth their while to search for others. Indeed, finding sizable online dispersion even after controlling for firm-specific effects suggests that online consumers—although better informed than their offline counterparts—still are not perfectly informed with respect to the distribution of prices. This finding is consistent

[40] In addition, a review of ratings at BizRate.com reveals that of those online sellers rated, all have roughly similar customer ratings.

[41] Similarly, Pan et al. (2002b, p.58) conclude with respect to their finding that hybrid sellers charge more than pure online sellers, "improving trust and entering online markets early might result in greater traffic and possibly higher prices."

[42] This is also consistent with hybrid sites charging higher prices. Having an offline presence may offer an assurance of trustworthiness to consumers, and hybrids may be able to charge for this.

with Sorensen (2000) and Pan et al. (2002b), who use similar techniques to conclude that interfirm heterogeneity is not the key driver of price dispersion.

4.2 Price Levels

Another prediction of search theory is that average margins should fall with search costs. Table 2 shows that average online prices are lower than average offline prices. Although finding lower online prices is consistent with lower online search costs, it also may reflect offline firms' provisions of costly services for which consumers are willing to pay.[43] Thus, online and offline firms may charge different prices, but have similar margins. Because models of price dispersion relate search costs to margins, it is impossible to know if lower online prices reflect more intense competition without detailed cost data, which is unavailable.

The marginal cost of selling disposable contact lenses is the wholesale price plus direct operating costs. As part of a settlement to an antitrust suit, Vistakon, Cibavision, and Bausch & Lomb each agreed to sell to online and offline channels on non-discriminatory terms.[44] Thus, it may be reasonable to assume that all channels enjoy similar wholesale prices, although large national offline chains may still be able to negotiate volume discounts that small online sellers cannot. Online and offline sellers, however, offer consumers different packages of service and convenience, which are likely associated with different cost structures. For example, optical chains and independent ECPs, may incur higher marginal operating costs than online sellers, warehouse clubs, and mass merchandisers by focusing only on ophthalmic goods and

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[43] It is important to note that in equilibrium, a firm cannot charge higher prices merely because it has higher costs. Higher offline prices attributable to higher costs would exist in equilibrium only if those higher offline costs are associated with providing consumers some service that they value.

[44] *In re Disposable Contact Lens Antitrust Litigation*, MDL 1030 (M.D. Fla. 2001).

typically operating in small settings located in professional offices and malls. Accordingly, in the price regressions I control for different retail packages that are likely to be associated with higher costs.

Specifically, I estimate the following equation:

$$\log p_{ij} = C + \alpha_i + \beta_1 OFFLINE_j + \beta_2 EYESONLY_j + \beta_3 INDEP_j + e_{ij}, \tag{3}$$

where p_{ij} is the price of lens i at outlet j, *OFFLINE* is a dummy variable equal to 1 if outlet j is an offline outlet and α_i is a lens-specific effect to capture unobserved cost and demand factors specific to each lens that may affect prices. I estimate (3) in the semi-log form so that coefficients may be more readily interpreted as percentage differences in prices.[45] I expect the estimated coefficient of *OFFLINE* to be positive. If online and offline prices differ due to offline outlets having higher costs, then $\hat{\beta}_1$ would be biased upward because it would include both cost and search factors that are affecting online and offline prices.

To control for factors that are likely associated with providing a higher-cost retail package, I include *EYESONLY* and *INDEP*. *EYESONLY* is equal to 1 if offline outlet j carries only ophthalmic goods. Unlike online sellers, such stores (optical chains and independent ECPs) provide eye care services and almost invariably operate in malls or office complexes, which are likely to be substantially more expensive locations than most online operations. Further, these stores are likely to sell smaller quantities than many online outlets and – unlike mass merchandisers or warehouse clubs, which also provide eye care services – are unable to spread their fixed costs over the sale of non-ophthalmic goods to reach equivalent average costs. *INDEP* is equal to 1 if offline outlet j is not

[45] Results of a linear specification are qualitatively and statistically unchanged.

affiliated with a national chain. Past empirical research into the effect of state-imposed restrictions on the commercial practice of optometry has suggested that chains may enjoy lower costs of operation than independent ECPs.[46]

The first column of Table 8 reports the baseline regression and shows that offline outlets sampled set prices that are on average 25% higher than those online. When cost differences are taken into account, however, this price differential remains significant but is more than cut in half. The second column of Table 8 shows that online merchants charge only 11.4% less on average for their lenses than offline merchants when controlling for business model differences that are likely associated with cost differences. The estimated coefficient on *EYESONLY* is significant and shows that stores selling only ophthalmic goods charge an average of 18 percent more for their lenses than other offline sellers. This result is consistent both with multiproduct retailers enjoying some economies of scope and scale and with consumers placing additional value on the retail package that stores specializing in ophthalmic goods offer. The estimated coefficient on *INDEP* is positive, but insignificant, suggesting that (at least in Northern Virginia) independent and commercial sellers of ophthalmic goods enjoy similar costs.[47]

Columns (4) and (5) of Table 8 report the same regressions as columns (1) and (2), but weight observations by share using the method reported in the previous section. When observations are weighted, both online and offline average prices increase; online prices increase because 1-800 Contacts' prices – which are on average the highest of all

[46] *See* Haas-Wilson (1986, 1987); FTC (1989).

[47] That independent ECPs and optical chains offer statistically equivalent pricing may be an artifact of Virginia's regulation prohibiting commercial optical goods sellers from employing an ECP directly. According to discussions with some industry representatives, in instances where the ECP is not an employee of the optical chain, the optical chain may allow the ECP to sell all replacement lenses as part of the compensation scheme.

the online merchants sampled – are much more important in the data, and average offline prices increase because ECPs and optical chains—the most expensive channels—take on greater importance. The results indicate that the increase in online prices due to greater weight being put on more expensive sellers overwhelmed the similar effect in the offline data. Although the baseline regression (reported in column 4) shows that offline prices are 23% higher than online prices, when costs are controlled for, the difference falls to only 6%, and is statistically insignificant.

The price dispersion results suggest that online and offline consumers may face similar search costs for Acuvue brand lenses. If this is true, it should be the case that the difference between online and offline prices for Acuvue lenses is smaller than those for other lenses in the sample. Table 9 reports estimations of equation (3) including an interaction dummy equal to 1 if lens *i* is an Acuvue brand lens and outlet *j* is an offline seller, allowing Acuvue lenses to act as the control group and other lenses as the treatment group. I expect the estimated coefficient on the Acuvue interaction dummy to be negative.

Consistent with the price dispersion results, regardless of whether costs are controlled for, the difference between online and offline prices for Acuvue brand lenses is about 14 percentage points less than for other lenses. This means that when costs are controlled for, online and offline prices for Acuvue lenses are roughly equivalent. At the same time, the coefficient on *OFFLINE* rises by about 4 percentage points. As shown in columns (4) and (5) of Table 9, these results are robust to weighting for intrachannel share. The results suggest that advertising likely already has reduced consumer search costs for Acuvue brand prices relative to other lenses, causing offline firms to compete more intensely for the sale of Acuvue brand lenses.[48] The Internet appears to have had the largest effect on the prices of lenses for which offline consumers have the least information.

So far, the estimates of differences in online and offline prices have not taken into account consumers' costs of obtaining the good, and thus may not provide a realistic picture of the actual trade-offs that consumers face. To purchase contacts offline, a consumer must incur the cost of physically traveling to the outlet, and although online shopping eliminates the need for consumers to travel to a store, the consumer pays the online outlet for delivery.[49] Table 10 shows the results of a regression of total price – list price with shipping and handling fees for the standard delivery option added to online prices – on *OFFLINE* and cost controls.[50] The estimated coefficient of *OFFLINE* shows that when travel costs associated with purchasing a lens offline are not included, lenses purchased offline are on average $6.20, or 7% more expensive than those purchased online. When we control for Acuvue lenses in column (2), the results show that with shipping and handling costs included, non-Acuvue lenses are $10.89, or 12% more expensive online and that Acuvue lenses are less expensive offline, although this difference is not statistically significant.

Although many trips may be undertaken for the sole purpose of purchasing contact lenses, in some circumstances it is appropriate to assume that consumers can

[48] As an additional robustness check, I ran the regressions reported in Tables 8 and 9 on a subset of lenses that were the most widely available, defined as missing from no more that two merchants (only one lens was available at all outlets). The lenses in the limited sample were Acuvue2, Biomedics55, Frequency55, Softlens66 Toric, and Frequency55 Toric. The results (not reported) are nearly identical in magnitude and statistical significance to those from the full sample.

[49] This price may be explicit in the form of a shipping and handling fee, or may be built in to the price of the lens in cases where online outlets offer free shipping.

[50] The dependent variable is in dollar, rather than log, form for ease in calculating total offline costs.

spread the fixed cost of travel over other shopping activities (e.g., grocery shopping while at Wal-Mart, clothes shopping while at the mall, running errands adjacent to an eye doctor's office or receiving an eye examination). Assuming a ten-mile round trip to an offline store takes one hour, and using the government reimbursement rate of $0.38/mile to proxy for direct costs (e.g., gas, depreciation) and $6.75 as the hourly opportunity cost of time,[51] Table 11 shows the offline premium under various assumptions of how the costs of travel should be allocated to the purchase of lenses.[52] The results show that regardless of how offline travel costs are allocated, lenses are less expensive online. For cases where a trip is solely for purchasing lenses – as may be more likely when purchasing from an independent ECP –lenses offline are on average 19% more expensive than lenses online. In instances where a consumer purchases so many items in addition to contact lenses that the allocation of travel costs to the contact lenses approaches zero (perhaps most relevant for warehouse clubs and mass merchandisers), higher search costs still cause offline lenses to be 7% more expensive.

Overall, the results of price comparisons indicate that average online prices for contact lenses are significantly less than those offered by offline merchants. This result is robust to controls for factors that may cause offline merchants to have higher costs, various assumptions of offline travel costs, and regardless of whether observations are weighted by share. Indeed, to the extent that controlling for whether an offline firm caries only ophthalmic goods and whether it is part of a commercial chain is likely to

[51] Henscher (1997) has estimated that the value of transit time for leisure trips (including shopping) is between 26 and 42 percent of the average wage. Small (1992) concludes that weekend time in transit is more highly valued than transit to work, and has offered 50 percent of the average wage as an approximation for the value of time in a journey to work. Using the Bureau of Labor Statistics (2003) of $17.75 average hourly wage and taking the mid-point of Small's and Henscher's estimates of the value of travel time yields an opportunity cost of time for travel to purchase contact lenses of $6.75 per hour.

[52] I implicitly assume that the time taken actually to complete the online and offline purchases is identical.

have captured the major cost differences between online and offline sellers of contact lenses, the results suggests that lower online search costs have spurred more intense competition among online than offline sellers, resulting in an 10-15% decrease in prices of non-Acuvue lenses.

An interesting aspect of the data is that online prices are statistically equivalent to warehouse club pricing. Table 2 shows that warehouse clubs and online firms offer similar prices, and columns (3) and (6) of Tables 8 and 9 show that when a dummy variable equal to 1 if outlet *j* is a mass merchandiser is added (which causes $\hat{\beta}_1$ to represent the average difference between online and warehouse club prices), $\hat{\beta}_1$ becomes much smaller (negative in three of the four specifications) and highly insignificant.[53] The results show that retailers in the sample offer prices that are 28% higher than average prices offered by warehouse clubs and online sellers. Similarly, the coefficient on *EYESONLY* almost doubles, reflecting the fact that the comparison group's average prices are lower because we have now controlled for the more expensive mass merchandisers.

One explanation for this result is that that warehouse clubs and online sellers enjoy similar costs but charge less than the remaining offline sellers because they offer consumers a less attractive retail package. That is, the results may merely be showing that online and offline consumers have similar information about sellers' prices, but are willing to pay a 30 percent premium to mass merchandisers, optical chains, and

[53] Because *EYESONLY* and *NONCOM* control only for price differences associated with chain and independent ECP business models, $\hat{\beta}_1$ in columns (2) and (4) of Tables 8 and 9 reflect the average difference between online pricing and the average of warehouse club and mass merchandiser pricing offline.

independent ECPs because these outlets offer a higher quality retail experience or have some other locational or reputational advantage over online sellers and warehouse clubs.[54]

Although the high-priced offline outlets may offer consumers some advantages, it is unclear that they would be sufficient to support a 30 percent premium in a full-information equilibrium. For example, consumers who enjoy the convenience of one-stop shopping may be willing to pay for this value in the form of higher prices. This explanation, however, would apply only to purchases made at the time of the eye examination – which typically is less than the amount that would last for the length of the prescription (1-2 years) – not replacement lenses bought during the course of the prescription.[55] Further, it is unlikely that high-price offline outlets offer consumers substantially greater convenience for purchasing replacement lenses: online stores deliver directly to the consumer's home and consumers typically will not need replacement lenses more quickly than an online firm can deliver them. And, although lines may be longer and the service less attentive, there is no reason to assume that a trip to a warehouse club is substantially more inconvenient than one to a mass merchandiser, independent ECP, or optical chain.[56] Consumers may be willing to pay more to purchase lenses from an outlet that employs and ECP because they perceive that they are receiving higher quality service. For example, consumers may be wary of purchasing a medical

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[54] The relative price for independent ECPs, mass merchandisers, and optical chains may be biased upwards to the extent that consumers purchasing from these channels tend to receive discounts due to managed vision plans in greater proportions than do consumers purchasing from other channels.

[55] As noted earlier, only 20% of contact lens wearers purchase a year's supply at the time of an examination.

[56] For example, a consumer can spread the fixed cost of time spent in transit over several shopping activities at a warehouse club, but cannot shop for anything other than optical goods at an independent ECP.

device without an ECP present to answer questions. Apart from quality concerns, moreover, some consumers may be wary of purchasing contacts online due to concerns about fraud that they do not have with a bricks-and-mortar store. Replacement lenses of the same prescription, however, are identical regardless of who sells them and the act of selling replacement lenses consists merely of dispensing a sealed product. Further, neither of these concerns is present with warehouse clubs.

There are other explanations for the data that are consistent with consumers enjoying lower search costs online. First, warehouse clubs may provide a retail package that is less attractive and less costly than what an online seller provides, but be able to charge a higher price than they otherwise would if their customers had more information regarding market prices. Thus, an equivalent price may reflect higher margins. Another explanation for the equality of online and warehouse club pricing is that in contrast with consumers who purchase from independent ECPs, optical chains, and mass merchandisers, consumers who shop at warehouse clubs may be expected to have greater knowledge of both online and offline prices. Thus, warehouse clubs – unlike other offline merchants – set prices on the assumption that most of their patrons know what other online and offline stores charge. The foregoing suggests that rather than there being separate online and offline markets for contact lenses, it may be more precise to view online and offline merchants of part of one market in which warehouse clubs and online vendors compete for informed customers, whereas the remaining offline sellers concentrate on making sales to their share of uninformed customers. In equilibrium, online sellers and warehouse clubs attract all of the informed consumers; online sellers serve only informed consumers and, because they employ ECPs, warehouse clubs serve the proportion of uninformed consumers who happen to choose to have their eye examination at a warehouse club.

If consumers are able to discern online and offline prices with equal ease, and mass merchandisers, independent ECPs, and optical chain charge higher prices merely to cover the additional costs of providing consumers something they value, we would expect to see similar margins across outlets. On the other hand, if online firms and cater only to informed consumers, they should have lower margins than their offline counterparts. Without detailed cost information (which currently is unavailable), it is impossible to know relative margins. Taken as a whole, however, the empirical results suggest that at least some proportion of the lower online prices is likely attributable to lower online search costs. For example, the price dispersion results are robust to the exclusion of warehouse clubs and to controls for interstore differentiation. Further, the data indicate that the online-offline price differential for Acuvue lenses is only half of what it is for non-Acuvue lenses; because it is unlikely that offline vendors have lower costs of selling Acuvue lenses than non-Acuvue lenses, this difference-in-difference suggests that the Internet has lowered consumer search costs non-Acuvue lenses.

5. Conclusion

It is a standard result that as consumers' search costs fall, firms will set lower prices based on an increasing probability that their patrons have—or will obtain—price information from their competitors. As all firms in a market respond the same way, prices converge toward the competitive level. Like other studies, this paper exploits the Internet's reduced information costs to test this hypothesis; because it is more costly to compare the prices of offline merchants than those of online merchants, theory predicts that all else constant, online prices should be lower and less dispersed than offline prices.

I examine the online and offline pricing of disposable contact lenses and find that under various weighting and transportation cost assumptions average online prices are lower than average offline prices and online prices are significantly less dispersed than offline prices. Specifically, I find that on average, consumers can save approximately 25 percent by purchasing contact lenses online. The amount of savings varies, however, depending on the offline comparison group. When I control for costs that are idiosyncratic to independent ECPs and optical chains, the results suggest that due to higher search costs offline prices are 11 percent higher than online prices. These results are robust to different weighting and assumptions about online and offline transportation costs (including time costs).[57] When all business models save warehouse clubs are taken into account, however, there is no statistical difference between online and offline prices, but the results show that mass merchandisers, optical chains, and independent ECPs charge around 30 percent more than online firms for the same lenses.

These results seem to beg the questions, if one can buy the same good more cheaply online or a warehouse club, why don't they, and why haven't all offline merchants lowered their prices to compete with their online counterparts? One obvious answer is that the Internet has not lowered all consumers' search costs. For example, not every contact lens wearer has access to the Internet. According to the Department of

[57] To the extent that offline prices in Northern Virginia are higher than those in other localities, the online and offline differences would be biased upward. A review of locality adjustments in pay for government employees shows that Washington D.C. metropolitan area upward adjustment is similar to that in other major urban area. For example, the locality pay adjustment for D.C. is 17.5%, compared with 15.1% for Atlanta, 19.9% for Boston; 21.15% for Chicago, 23.1% for Los Angeles; 17.8% for Miami, 18.4% for Philadelphia, 22.9% for New York; 15.5% for Raleigh-Durham; 17.9% for Seattle, and 28.6% for San Francisco. Thus, it would be reasonable to assume that these results would be likely to hold for major segments of the population. Further, the ranking of prices charged by channels is similar to those found in other public data submitted to the FTC (available from author upon request). Future research, however, would include offline samples from both urban and rural areas.

Commerce (2004) as of October 2003, approximately 28 percent of Americans from 14 - 49 (the demographic representing 75 percent of contact lens wearers (*see* 1-800 Contacts 2005b, at p.9)) are not "Internet users." Internet usage is positively correlated with income, however, so to the extent that contact lens usage also is positively correlated with income, the true proportion of contact lens wearers that do not use the Internet is likely to be lower.

Another factor that is likely to play a role is the relative youth of the market for replacement lenses. Some consumers still may be unaware that someone other than their prescribing ECP can fill their contact lens prescription or, even if they are aware that they can shop their prescription around, they may not know that replacement lenses are sold by outlets other than independent ECPs and optical chains. Consumers will get an additional price quote only if the expected benefit is greater than or equal to the cost of obtaining the quote. General lack of market information – both the lower bound of the price distribution and specific prices in the distribution – coupled with the fact that a consumers' first draw from the price distribution will be from an offline seller would tend to create inertia toward purchasing from the prescribing ECP. This is likely to help explain why independent ECPs and optical chains charge the highest prices and together account for over 70 percent of contact lens sales.

As the relatively nascent market for replacement lenses develops consumers are likely to become more aware of, and comfortable with, their options. More intense competition among contact lens sellers should accompany this increased consumer knowledge, allowing the goal of FCLCA to be realized more fully. Increased consumer knowledge in this market could have important welfare implications. As discussed earlier, FCLCA was intended to intensify competition among contact lens sellers by allowing consumers to shop their prescriptions around. Currently many consumers may not be aware of the full range of their options, but the data indicate that if most consumers were to become aware that lower prices exist online, the savings could be substantial.

The results also suggest that contact lens wearers in states that have and enforce state licensing regulations in a manner that impede online sellers' ability to operate would gain if these laws were eliminated. For example, 1-800 Contacts (2004b, p. 31) notes that North Carolina, Tennessee, Mississippi and Washington have laws or regulations that "purport to require anyone selling contact lenses to hold a valid ECP license issued by the state," and that Alaska and Georgia have considered similar laws. Further, current Georgia law requires that contact lens sales take place in a "face-to-face" transaction,[58] and Arizona and New Hampshire require that nonresident sellers of contact lenses register with the state optometry board and hold a valid optometry or pharmacy license from their home state.[59] Although the extent to which states enforce these restrictions against online sellers of contact lenses is unknown, these laws have the potential to raise online sellers' costs of serving consumers in these states, causing them to raise their prices.

In equilibrium, offline firms can charge higher prices than their online counterparts for the same lenses only if they are providing consumers something additional of value. Thus, unless independent ECPs, optical chains, and mass merchandisers enjoy persistent quality or locational advantages over online sellers, we

[58] GA. CODE ANN. § 31-12-12(h).

[59] *See*, *e.g*., ARIZ. REV. STAT. ANN. § 32-1773; N.H. RSA § 327:31.

should expect to see online and offline prices converge as more consumers become informed about their marketplace options. If observed price differences are solely a function of higher offline costs, however, increased consumer information will cause shares of higher-priced offline outlets to fall as their business models become unprofitable. Future research would examine a sample of online and offline prices for contact lenses over time to see if this occurs.

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Appendix

The average standard deviation of online price lenses prices (S^{on}) is calculated as $\frac{1}{10}\sum_{i=1}^{10} s_i^{On}$, where s_i^{On} is the standard deviation of lens *i*, as measured by deviation from the mean online price of lens *i* over all online stores.

Specifically, $s_i^{On} = \sqrt{\frac{1}{k-1}\sum_j \left(p_{ij} - \overline{p}_i^{On}\right)^2}$, p_{ij} is the price of lens *i* at store *j*, *k* is the number of online stores sampled that carried lens *i*, and $\overline{p}_i^{On}$ is the average price of lens *i* over all *k* online stores. The average online coefficient of variation ($S^{On}/\overline{P}^{On}$) is calculated as $\frac{1}{10}\sum_{i=1}^{10} \frac{s_i^{On}}{\overline{p}_i^{On}}$. The same methodology is used to calculate S^{Off} and $S^{Off}/\overline{P}^{Off}$.

The average range of online prices (R^{On}), is calculated as $\frac{1}{10}\sum_{i=1}^{10} R_i^{On}$, where $R_i^{On} = (\overset{Max}{p_i^{On}} - \overset{Min}{p_i^{On}})$. The average online normalized range ($R^{On}/\overline{P}^{On}$) is calculated as $\frac{1}{10}\sum_{i=1}^{10} \frac{R_i^{On}}{\overline{P}_i^{On}}$. The same methodology is used to calculate R^{Off} and $R^{Off}/\overline{P}^{Off}$.

TABLE 1

AVAILABILITY

Online Outlet	Percent of Lenses Carried	Offline Outlet	Percent of Lenses Carried
1-800 Contacts	100	BJ's Wholesale Club	100
1-Save-on-Lens	100	Clear Vision Express	100
Aalens.com	30	Hoang & Bradley	90
Aclens	100	Hour Eyes	100
America's Best Online	80	Lenscrafters	100
BJ's Online	90	MacDonald Eye Care	90
CLE Contact Lenses	90	May & Hettler	100
Coastal Contacts	100	Northern Virginia Doctors of Optometry	90
Contact Lens King	100	Pearle Vision	90
Contact Lenses Discount	90	Rosslyn Eye Associates	100
Contactsland.com	100	Sam's Club	90
Discount Contact Lenses	100	Sears	100
First Choice Contacts	90	Target	100
Lens Discounters	100	Wal-Mart	90
Lenses for Less	100		
Lensmart.com	50		
Sears Online	70		
The Contact Lens Store	100		
Vision Direct	100		
Wal-Mart Online	80		
Average	88.5%		95.7%

Notes: Availability computed as percentage of lenses sampled available at outlet j.

TABLE 2
SUMMARY STATISTICS

	All Lenses				*Spherical*				*Specialty*			
Channel	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max
All Online	87.92 (91.70)	38.90 (38.31)	29.90 (33.85)	259.96 (259.96)	65.51 (69.57)	16.37 (15.95)	29.90 (33.85)	103.96 (103.96)	119.85 (123.23)	39.45 (38.84)	69.98 (74.98)	259.96 (259.96)
Pure	84.40 (88.47)	35.72 (35.25)	29.90 (33.85)	191.96 (201.96)	63.57 (68.00)	15.51 (15.51)	29.90 (33.85)	95.80 (101.75)	113.93 (117.45)	35.51 (35.09)	69.98 (74.98)	191.96 (201.96)
Hybrid	103.85 (106.38)	48.42 (47.85)	39.98 (39.98)	259.96 (259.96)	74.19 (76.62)	17.73 (16.43)	39.98 (39.98)	103.96 (103.96)	147.20 (149.86)	46.44 (45.39)	106.91 (106.91)	259.96 (259.96)
All Offline	107.95	45.82	31.86	280	81.89	16.56	31.86	112	146.36	48.41	73.52	280
Warehouse	83.18	36.51	31.86	180	60.11	13.83	31.86	80	114.91	34.16	73.52	180
Mass Merchandiser	108.38	43.01	69.92	216	79.39	10.49	69.92	99.80	148.23	38.28	90.00	216
Optical Chain	109.02	40.84	40.00	239.80	86.61	15.77	40.00	112	143.37	43.91	88.00	239.80
Independent ECP	115.63	50.86	44.00	280	86.56	13.89	44.00	112	158.61	55.29	76.00	280
All Channels Combined	96.55	43.11	29.90	280	72.69	18.32	29.90	112	131.13	45.26	69.98	280

Notes: Unit of observation is price of lens *i* at outlet *j*. Observations are not weighted for intrachannel shares. Statistics including shipping and handling costs are in parentheses. Statistics for *All Channels Combined* computed without including shipping and handling costs.

TABLE 3
ONLINE AND OFFLINE PRICE DISPERSION

	All			Acuvue			Non Acuvue		
	Online	Offline	Offline (Warehouse Excluded)	Online	Offline	Offline (Warehouse Excluded)	Online	Offline	Offline (Warehouse Excluded)
Std. Dev.	8.53	19.77*** (0.01)	16.80** (0.02)	6.27	11.65** (0.05)	7.02 (0.14)	9.49	23.26*** (0.01)	20.99** (0.03)
Std. Dev./ Ave. Price	0.10	0.19*** (0.01)	0.15* (0.10)	0.08	0.14 (0.14)	0.08 (0.42)	0.10	0.20** (0.02)	0.18** (0.05)
Range	33.33	67.62*** (0.01)	53.30** (0.05)	23.56	37.75** (0.05)	23.99 (0.99)	37.52	79.99** (0.02)	65.87* (0.06)
Range /Ave. Price	0.37	0.62** (0.02)	0.47 (0.24)	0.31	0.45** (0.05)	0.27 (0.30)	0.39	0.69** (0.04)	0.56 (0.15)

Notes: Standard deviation, coefficient of variation, range, and standardized range are measured for a specific lens across all store in either the online or offline channel, and then averaged over all lenses sampled. *See* Appendix for details of how dispersion measures were calculated. *P*-values from a Wilcoxon rank-sign test for difference between relevant offline and online dispersion measure are in parentheses. ***significant at 1% level, one-tailed test; **significant at 5% level, one-tailed test; *significant at 10% level, one-tailed test.

TABLE 4
WEIGHTED ONLINE AND OFFLINE PRICE DISPERSION

	All			Acuvue			Non Acuvue		
	Online	Offline	Offline (Warehouse Excluded)	Online	Offline	Offline (Warehouse Excluded)	Online	Offline	Offline (Warehouse Excluded)
Std. Dev.	8.40	20.08*** (0.01)	18.18*** (0.01)	6.60	9.55** (0.05)	6.32 (0.99)	9.17	24.59*** (0.01)	23.27*** (0.01)
Std. Dev./ Ave. Price	0.09	0.18*** (0.01)	0.16* (0.09)	0.06	0.11* (0.09)	0.07 (0.30)	0.09	0.21*** (0.01)	0.19*** (0.01)
Range /Ave. Price	0.35	0.60** (0.02)	0.47 (0.11)	0.23	0.44** (0.05)	0.27 (0.30)	0.37	0.66** (0.04)	0.55* (0.09)

Notes: Standard deviation, coefficient of variation, range, and standardized range are measured for a specific lens across all store in either the online or offline channel, and then averaged over all lenses sampled. *See* Appendix for details of how dispersion measures were calculated. Range is omitted because it does not vary with weighting. *P*-values from a Wilcoxon rank-sign test for difference between relevant offline and online dispersion measure are in parentheses. ***significant at 1% level, one-tailed test; **significant at 5% level, one-tailed test; *significant at 10% level, one-tailed test.

TABLE 5
PRICING DISTRIBUTIONS FOR ONLINE AND OFFLINE SELLERS

Online				Offline			
Outlet	Low Price	Middle	High Price	Outlet	Low Price	Middle	High Price
1-800 Contacts	1	2	7	BJ's Wholesale Club	7	3	0
1-Save-on-Lens	0	3	7	Clear Vision Express	4	6	0
Aalens.com	1	0	2	Hoang & Bradley	0	0	8
Aclens	0	7	3	Hour Eyes	0	7	3
CLE Contact Lenses	3	3	3	Lenscrafters	4	1	5
Coastal Contacts	8	2	0	MacDonald Eye Care	3	5	2
Contact Lens King	5	4	1	May & Hettler	0	4	6
Contact Lenses Discount	9	0	0	Northern Virginia Doctors of Optometry	0	3	6
Contactsland.com	2	8	0	Pearle Vision	0	6	3
Discount Contact Lenses	0	10	0	Rosslyn Eye Associates	4	6	0
First Choice Contacts	0	7	2	Sam's Club	9	0	0
Lens Discounters	5	4	1	Sears	2	4	4
Lenses for Less	0	4	6	Target	4	5	1
Lensmart.com	0	1	4	Wal-Mart	4	3	2
The Contact Lens Store	4	5	1				
Vision Direct	0	9	1				

TABLE 6
ONLINE AND OFFLINE PRICE DISPERSION
MEASURED BY RESIDUALS FROM FIXED-EFFECTS REGRESSION

	All		Acuvue		Non-Acuvue	
	Online	Offline	Online	Offline	Online	Offline
Std. Dev.	7.10	13.90*** (0.01)	5.24	10.03** (0.05)	7.88	15.56** (0.03)
Std. Dev./ Ave. Price	0.08	0.13** (0.03)	0.07	0.12** (0.05)	0.09	0.14* (0.06)
Range	30.44	46.39** (0.03)	21.46	32.48** (0.05)	34.29	52.36* (0.06)
Range /Ave. Price	0.37	0.45 (0.11)	0.35	0.38 (0.14)	0.37	0.48 (0.20)

Notes: Notes: Standard deviation, coefficient of variation, range, and standardized range are measured for a specific lens across all store in either the online or offline channel, and then averaged over all lenses sampled. *See* Appendix for details of how dispersion measures were calculated. *P*-values from a Wilcoxon rank-sign test for difference between relevant offline and online dispersion measure are in parentheses. ***significant at 1% level, one-tailed test; **significant at 5% level, one-tailed test; *significant at 10% level, one-tailed test.

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TABLE 7

ACUVUE AND NON-ACUVUE LENSES:
DIFFERENCE-IN-DIFFERENCE FOR MEASURES OF PRICE DISPERSION

	Δ			
	Std. Dev.	Range	Std. Dev./Ave. Price	Range/Ave. Price
Unweighted Price	8.43 (0.15)	30.28 (0.11)	0.07 (0.11)	0.16 (0.21)
Unweighted Price (without warehouse)	10.74** (0.04)	27.92** (0.04)	0.10* (0.07)	0.21 (0.12)
Weighted Price	15.17*** (0.01)	-	0.09* (0.09)	0.15 (0.24)
Weighted Price (without warehouse)	14.37*** (0.01)	-	0.12** (0.02)	0.21** (0.04)
Residuals	2.90 (0.21)	7.91 (0.21)	0.01 (0.34)	0.09 (0.21)

Notes: Notes: Standard deviation, coefficient of variation, range, and standardized range are measured for a specific lens across all store in either the online or offline channel, and then averaged over all lenses sampled. *See* Appendix for details. Range is omitted for weighted statistics because it does not vary with weighting. p -values from a Wilcoxon ranksum test are in parentheses. ***significant at 1% level, one-tailed test;**significant at 5% level, one-tailed test; *significant at 10% level, one-tailed test.

TABLE 8
REGRESSION RESULTS FOR LOG LENS PRICE

	Unweighted			Weighted		
	(1)	(2)	(3)	(4)	(5)	(6)
OFFLINE	0.251*** (0.021)	0.114*** (0.037)	-.027 (0.039)	0.227*** (0.033)	0.058 (0.044)	-0.083 (0.046)
EYESONLY		0.179*** (0.043)	0.320*** (0.044)		0.179*** (0.043)	0.320*** (0.045)
INDEP		0.020 (0.036)	0.020 (0.036)		0.022 (0.036)	0.022 (0.053)
MASS MERCHANDISER			0.282*** (0.054)			0.282*** (0.053)
CONSTANT	4.15*** (0.30)	4.16*** (0.026)	4.16*** (0.024)	4.20*** (0.058)	4.21*** (0.056)	4.21*** (0.056)
R^2	0.83	0.85	0.87	0.81	0.82	0.83
F	162.72***	174.24***	183.31***	84.63***	78.32***	76.93***

Notes: N = 279. Unit of observation is the log of price of lens *i* at outlet *j*. Robust standard errors in parentheses. ***significant at 1% level; **significant at 5% level. Acuvue lenses is the omitted category for lens fixed-effects.

TABLE 9
REGRESSION RESULTS FOR LOG LENS PRICE WITH ACUVUE INTERACTION

	Unweighted			Weighted		
	(1)	(2)	(3)	(4)	(5)	(6)
OFFLINE	0.290***	0.154***	0.013	0.269***	0.101**	-0.040
	(0.027)	(0.340)	(0.41)	(0.043)	(0.50)	(0.051)
OFFLINE*ACUVUE	-0.137***	-0.132***	-0.132***	-0.144***	-0.139***	-0.139***
	(0.038)	(0.033)	(0.030)	(0.057)	(0.056)	(0.056)
EYESONLY		0.178***	0.319***		0.178***	0.320***
		(0.043)	(0.044)		(0.043)	(0.045)
INDEP		0.018	0.018		0.020	0.020
		(0.036)	(0.036)		(0.037)	(0.037)
MASS MERCHANDISER			0.282***			0.282***
			(0.052)			(0.050)
CONSTANT	4.19***	4.20***	4.20***	4.25***	4.25***	4.25***
	(0.027)	(0.024)	(0.023)	(0.053)	(0.052)	(0.052)
R^2	0.84	0.86	0.88	0.81	0.83	0.84
F	149.03***	158.83***	167.65***	90.03***	85.45***	86.44***

Notes: N = 279. Unit of observation is the log of price of lens *i* at outlet *j*. Robust standard errors in parentheses. ***significant at 1% level; **significant at 5% level. Acuvue lenses is the omitted category for lens fixed-effects.

TABLE 10
REGRESSION RESULTS FOR TOTAL LENS PRICE

	(1)	(2)
OFFLINE	6.20**	10.89***
	(3.24)	(3.61)
OFFLINE*ACUVUE		-15.66***
		(3.14)
EYESONLY	16.30***	16.23***
	(3.88)	(3.87)
INDEP	4.00	3.77
	(4.00)	(3.96)
CONSTANT	65.99***	71.11***
	(2.15)	(1.64)
R^2	0.85	0.86
F	77.89***	79.17***

Notes: N = 279. Unit of observation is total price of lens *i* at outlet *j*. Robust standard errors in parentheses. ***significant at 1% level; **significant at 5% level. Acuvue lenses is the omitted category for lens fixed-effects.

TABLE 11
ESTIMATED OFFLINE PREMIUM WITH TRANSPORTATION COSTS

	Premium (%)	
Trip Cost Allocation (%)	All Lenses	Non-Acuvue
0	7.0	11.7
50	13.0	17.3
100	18.9	23.0

Notes: The relevant offline premium is calculated by dividing coefficient on OFFLINE from Table 10 plus relevant trip costs by the average online price for all lenses ($88.47) and non-Acuvue lenses ($93.26).