WORKING PAPERS

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

James C. Cooper

WORKING PAPER NO. 283

Original Version: April 2006
Revised: November 2006

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

James C. Cooper*

Federal Trade Commission
600 Pennsylvania Ave., N.W.
Washington, D.C. 20580
202-326-3367 (phone)
202-326-3548 (fax)
jcooper1@ftc.gov

November 29, 2006

Abstract: I examine online and offline prices for popular disposable contact lenses. Idiosyncratic features of this market make it likely that offline firms set prices on the assumption that most of their customers are unaware of online prices. Consistent with lower online search costs, offline prices are more dispersed and approximately 11 percent higher than online prices when controlling for differentiated retail services. I also find that the Internet has had a smaller effect on the prices of widely-advertised lenses. Overall, the results suggest that contact lens consumers still are relatively uninformed about their options.

JEL Classification: K20, L81, L10, D83

Key Words: Contact Lenses, Price Dispersion, Search Costs, Internet, E-commerce

*

1. Introduction

Theory predicts that price dispersion and margins should be positively related to consumer search costs.[1] 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 or she 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. 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. Conversely, when search is costly, consumers visit fewer stores. Because consumers with positive search costs do not learn the entire price distribution, they are more likely to buy from a store that does not offer the lowest price.

It is reasonable to assume that consumers can shop among competing online merchants more cheaply than offline merchants.[2] Recently, several economists have taken advantage of this "natural experiment" to test the predictions of search theory by comparing online and offline price distributions of commodity goods.[3] This line of

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

[2] 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. The online firm, then, must set its prices on the assumption that anyone visiting its Website has seen – or will see – 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. *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.

[3] *See, e.g.*, Clay et al. (2002); Clemons, Hann, and Hitt (2002); Lee and Gosain (2002); Clay, Krishnan, and Wolff (CKW) (2001); Brynjolfsson and Smith (2000); Bailey (1998). Several economists have found

of online and offline price dispersion for widely-advertised lenses is only about half that for the remainder of the lenses in the sample. Further, average online and offline prices of widely-advertised lenses are statistically equivalent in contrast to non-advertised lenses. These results suggest that online markets have had less of an impact on the pricing for widely-advertised lenses than other lenses.

This study improves on previous work comparing online and offline prices to test search theory in two ways. First, one assumption implicit in previous studies of online and offline pricing is that offline stores set prices based on expectations of their patrons' knowledge of other offline firms' prices, not online prices.[5] 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.

Although it is reasonable to assume that those who shop at one online outlet are likely to obtain many additional online quotes, 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 idiosyncratic reasons – a large proportion of those who shop offline obtain only offline quotes. 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

[5] 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.

one reason why studies of these goods have arrived at no consensus that online and offline prices are statistically different.

A variety of factors likely have caused many consumers to remain unaware of their full range of options beyond their prescribing eye care professional (ECP). For example, prescribing ECPs in all states were not required to release contact lens prescriptions to their patients until 2004.[6] Prior to the Fairness to Contact Lens Consumers Act (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 prescribing ECP.[7] 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).[8]

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.[9] Given the relative youth of the replacement contact lens market, state regulatory

---

[6] 15 U.S.C. § 7601; 16 C.F.R. § 315.3. FCLCA prohibits ECPs from tying contact lens sales to eye examinations and requires ECPs to release their patients' prescriptions.

[7] *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.

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

[9] 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.

impediments, lack of consumer knowledge of their right to their prescription, and reported 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.[10] Because prescribing ECPs can be affiliated only with offline sellers, in contrast with goods previously studied, there are strong prior reasons to believe that a large proportion of offline contact lens sellers' customers are unaware of online pricing.

A second improvement on previous work is that unlike previous studies in this area, I take advantage of the variation in offline business models to control for the provision of costly retail services that consumers may value. Search theory relates margins, not prices, to consumer search costs; unless it is reasonable to assume that online and offline merchants have similar costs, a comparison of prices alone is not likely to provide much information about search costs. Although I find that offline prices are on average higher than online prices, I also find that the magnitude and significance of this result depends on the composition of the offline sample. When controls are added for features specific to certain offline vendors, the average difference between online and offline prices falls dramatically. These results suggest that absent data on costs, the choice of offline comparison group will influence measured price differences and thus inferences regarding search costs.

[10] Indeed, data indicate substantial inertia toward purchasing from prescribing ECPs; independent ECPs

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

The FDA approved soft contact lenses in 1971, but in the early stages of development, they were manufactured in a way that did not always accurately reproduce the original prescription. Because each lens required a great deal of ECP effort to fit, consumers generally purchased lens from their ECP after an exam and replaced them infrequently. The evolution in contact lens manufacturing technology now allows the sale of lenses to be unbundled from the fitting exam. Technological improvements have solved standardization problems; the replacement lens a consumer purchases pursuant to a prescription that specifies a brand will be identical, regardless of where it is purchased. These advances have transformed contact lenses of the same brand and prescription into commodities.[11] 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.

A consumer needs a prescription from an ECP to purchase contact lenses, which will specify a brand name typically will last between one and two years.[12] Data indicate

[11] 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.

[12] Under FCLCA, unless there are special health-related circumstances, a contact lens prescription must last at least one year. 15 U.S.C. § 7604(a). Under some state laws, a prescription can last for as long as two years.

that 70-80% of contact lens wears purchase less than a year's supply at a time, so most will purchase lenses at least twice during the length of their prescription.[13] Under FCLCA, contact lens prescriptions are portable; despite some prior contradictory state law and industry practice, ECPs must provide patients with a copy of their contact lens prescription to allow them to purchase their lenses from whomever they wish. According to public data, independent ECPs (both optometrists and ophthalmologists) account 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.[14] The same data has online and mail order outlets accounting for between 8 and 13 percent of sales.

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), 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

[13] 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).

[14] *See* FTC (2005, p. 11).

[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.

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). According to Census 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.[22] 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.[23] 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 toric lenses.[24] Finally, Bausch & Lomb's Softlens Multifocal is the leading multifocal lens.[25]

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

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

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

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

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

for "contact lenses" at shopping.com, a price comparison search engine.[26] 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.[27] 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, (Luxottica and Eye Care Centers of America).[28] 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.[29] For every outlet sampled, researchers collected information 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, presum compared with $8.53 online. A Wilcoxon rank-sign test shows all differences are

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 contrast, are relatively homogeneous and all share the same "location" from consumers' perspectives.[35]

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

[35] Several studies comparing online and offline pricing of books and CDs have 2 Tw0cI8rp andt5 0 high.fwe0009edidb011 toa -045

> 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] These results also are consistent with those of Smith and Brynjolfsson (2001), who find that the most heavily branded online retailers charge higher prices than less well-known online retailers.

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 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. In support of this hypothesis, Table 2 shows that average online prices are lower than average offline prices. I also estimate the following equation:

---

[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]

$$\log p_{ij} = C + \alpha_i + \beta_1 OFFLINE_j + e_{ij}\ , \qquad (2)$$

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 (2) in the semi-log form so that coefficients may be more readily interpreted as percentage differences in prices.[43] The first column of Table 7 reports results of this baseline regression and, as expected the estimated coefficient of *OFFLINE* is positive and significant, showing that offline outlets sampled set prices that are on average 25 percent higher than those online.[44]

Although finding that higher average offline prices is consistent with lower online search costs, it also may reflect offline firms' provision of costly services for which consumers are willing to pay.[45] If offline outlets charge more because consumers value the additional services they provide, then $\hat{\beta}_1$ would be biased upward because it would include the premium that consumers are willing to pay for these services. That is, online and offline firms may charge different prices for different price/quality packages, but

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

[44] 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, howes5ress8jcolduld cld Tw-l9(s5re

commercial sellers of ophthalmic goods enjoy similar costs.[47]

club and online prices are statistically equivalent. The results in columns 3 and 6 of Table 7 show that mass merchandiser pricing is much closer to that of optical chain and independent ECP pricing is driving the sign and significance $\hat{\beta}_1$; when a dummy variable equal to 1 if outlet *j* is a mass merchandiser is added (which causes $\hat{\ }_1$

different price/quality combinations; consumers may willingly pay around 30 percent more to purchase lenses from optical chains, mass merchandisers, and 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.[48]

An alternative explanation consistent with lower online search costs is that mass merchandisers charge a premium over warehouse clubs because they primarily serve consumers who are unlikely to have knowledge of online or warehouse club pricing. Consumers who shop at warehouse clubs – perhaps due to lower opportunity costs of time – may be expected to have greater knowledge of both online and offline prices. 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, and the remaining offline sellers concentrate on making sales to their share of uninformed customers. Thus, warehouse clubs – like online outlets – set prices on the assumption that most of their patrons know what other online and offline stores charge. High-price offline outlets, on the other hand, set their prices on the assumption that their customers have very little knowledge of actual prices.

These results demonstrate the sensitivity of online and offline price comparisons to the offline control group. Previous studies have either sampled only one type of offline retailer [*e.g.*, Clay et al. 2002] or sampled different types of offline retailers, but failed to control for business model differences [*e.g.*, Brynjolfsson & Smith 2000]. As

[48] 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.

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 8 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.[51] Further, these results generally are 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.

The price dispersion results suggest that due to advertising 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 (2) 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.

[51] 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.

Consistent with search theory, the data suggest that the Internet has had the largest impact on the prices of lenses for which offline consumers have the least information. The difference between online and offline prices for Acuvue brand lenses is about 14 percentage points less than for other lenses. When business model differences are controlled for, online and offline prices for Acuvue lenses are roughly equivalent, and the coefficient on *OFFLINE* rises by about 4 percentage points. As shown in columns 3 and 4 of Table 9, these results are robust to weighting for intrachannel share.[52] It appears that advertising has informed consumers about offline prices for Acuvue brand prices, causing offline firms to set prices for Acuvue brand lenses on the assumption that a relatively large proportion of consumers with prescriptions for Acuvue lenses know the competitors' prices.

4.4 Transportation Costs

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 prices – on *OFFLINE* and business model controls.[54] 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 percent 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 percent 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 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,[55] Table 11 shows the offline premium under various assumptions of how the costs of travel should be allocated to the purchase of lenses.[56] 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 percent more

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

[55] 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.

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

expensive than lenses online. In instances when 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 percent more expensive.

5. Conclusion

With these caveats in mind, however, taken as a whole the empirical results seem to indicate that online contact lens markets are more efficient than their offline counterparts so that at least some portion of measured 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. Finally, because selling replacement contact lenses consists only of transferring a pre-packaged product to the consumers – almost always without the involvement of an ECP – one has to wonder whether fully-informed consumers are wiling to pay an additional $60 a year to purchase lenses from a mass merchandiser, optical chain, or independent ECP.

The empirical results seem to beg the following questions: if consumers can buy the same good more cheaply online or at 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; not every contact lens wearer has access to the Internet. According to the Department of 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."[57]

Another factor to consider is the relative youth of the market for replacement lenses and its regulatory history. Many consumers still are likely to 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 discussed earlier, FCLCA was intended to intensify competition among contact lens sellers by allowing consumers to shop their prescriptions around. The data suggest that many consumers still are unaware of their full range of options. As relatively nascent market for replacement lenses develops, however, consumers are likely to become more mindful 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

[57] Internet usage is likely 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 probably to be lower.

knowledge in this market could have important welfare implications. Further, contact lens wearers in states that have and enforce regulations in a manner that impede online sellers' ability to operate woul 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.

Bibliography

1-800 Contacts. 2004a. Comment in Response to FTC's Contact Lens Study, 69 Fed. Reg. 21,833 (Apr. 22, 2004).

____________. 2004b. Comment in Response to FTC's Proposed Contact Lens Rule, Ophthalmic Practice Rules, 69 Fed. Reg. 5440 (Feb. 4, 2004).

Bailey, Joseph P. 1998. "Electronic Commerce: Prices and Consumer Issues for Three Products: Books, Compact Discs, and Software." OECD/GD 98(4).

Bakos, Janis Y. 1997. "Reducing Buyer Search Costs: Implications for Electronic Marketplaces." *Management Science*. 43: 1676-92.

Baye, Michael R., Morgan, John, and Patrick Scholten. 2004. "Price Dispersion in the Small and in the Large: Evidence from and Internet Price Comparison Site." *J. Industrial Econ.*: 52: 463-96.

Benham, Lee. 1972. "The Effect of Advertising on the Price of Eyeglasses." *J. Law & Econ.* 15: 337-52.

Brown, Jeffrey R. and Goolsbee, Austan. 2002. "Does the Internet Make Markets More Competitive? Evidence from the Life Insurance Industry." *Journal of Political Economy*. 110: 481-507.

Brynjolfsson, Erik and Smith, Michael D. 2000. "Frictionless Commerce? A Comparison of Internet and Conventional Retailers. *Management Science*. 49: 563-85.

Burdett, Kenneth and Judd, Kenneth L. 1983. "Equilibrium Price Dispersion." *Econometrica*. 51:955-70.

Carlson, John and McAfee, R. Preston. 1983. "Discrete Equilibrium Price Dispersion." *Journal of Political Economy*. 91: 480-493.

Clay Karen, Krishnan Ramayya, and Eric Wolff. 2001. "Prices and Price Dispersion on the Web: Evidence from the Online Book Industry." *Journal of Industrial Economics*. 49: 521-39.

___________________________________ and Danny Fernandes. 2002. "Retail Strategies on the Web: Price and Non-Price Competition in the Online Book Industry." *Journal of Industrial Economics*. 50: 351-67.

Clemon, Eric K., Hann, Il-Horn, and Lorin M. Hitt. 2002. "Price Dispersion and Differentiation in Online Travel: An Empirical Investigation." *Management Science*. 48: 534-549.

Dahlby, Bev and West, Douglas. 1986. "Price Dispersion in an Automobile Insurance Market." *Journal of Political Economy*. 94:418-38.

Elberse, Antita, Barwise, Patrick and Kathy Hammond. 2002. "The Impact of The Internet on Horizontal and Vertical Competition: Market Efficiency and Value Chain Reconfiguration," in Baye, Michael R. *The Economics of the Internet and E-Commerce* 1-27.

Ellison, Glenn and Ellison, Sara Fisher. 2005. "Lessons About Markets from the Internet." *Journal of Economic Perspectives*. 19: 139-58.

Federal Trade Commission. 1980. *The Effects of Restrictions on Advertising and Commercial Practice in the Professions: The Case of Optometry*.

_______________________. 1983. *A Comparative Analysis of Cosmetic Lens Fitting by Ophthalmologists, Optometrists, and Opticians*.

_____________________. 2004. *Possible Anticompetitive Barriers to E-Commerce: Contact Lenses.*

_____________________. 2005. *The Strength of Competition in the Sale of Prescription Contact Lenses: An FTC Study*.

Feldman, Roger and Begun, James. 1978. "The Effects of Advertising Restrictions: Lessons from Optometry." *J. Human Resources* 13: 247-62.

FTN Midwest Research Securities Corp. 2004. "June 2004 Monthly Contact Lens Industry Survey."

GoolsbeTc - 20O2oes. ourcesp

__________. 1987. “Tying Requirements in Markets with Many Sellers: The Contact Lens Industry.” *Rev. Econ. & Statistics* 69:170 – 75.

Hensher, David A. 1997. “Uncovering the Distribution of Motorists’ Preferences,” in Green, Jones, and Delucchi eds. *The Full Costs and Benefits of Transportation*.

Jobson Optical Research, *The State of the Optical Market*, 2nd Quarter, 2003, *at* http://optistock.com/jobson-som-2003-06.pdf.

Lee, Zoonky and Gosain, Sanjay. 2002. “A Longitudinal Price Comparison for Music CDs in the Electronic and Brick-and-Mortar Markets: Pricing Strategies in Emergent Electronic Commerce.” *Journal of Business Strategies* 19: 55-72.

John Kwoka. 1984. “Advertising and the Price and Quality of Optometric Services.” 74 *Am. Econ. Rev*. 74: 211-16.

Pan, Xing, Shankar, Venkatesh and Brian T. Ratchford. 2002. “Price Competition Between Pure Play Versus Bricks-And-Clicks E-Tailers: Analytical Model and Empirical Analysis,” in Baye, *Michael R. The Economics of the Internet and E-Commerce* 29-61.

________, Ratchford, Brian T., and Venkatesh Shankar. 2002. “Can Price Dispersion Online Be Explained by Differences in E-Tailer Service Quality?” *Journal of the Academy of Marketing Science*. 30: 433-45.

Salop, Steven C., and Stiglitz, Joseph E. 1977. “Bargains and Ripoffs: A Model of

U.S. Census Bureau. 2004. *Ophthalmic Goods Manufacturing: 2002*.

U.S. Department of Commerce. 2004. *A Nation Online: Entering the Broadband Age*.

Van Hoomissen, Theresa. "Price Dispersion and Inflation: Evidence from Israel."

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}/

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 Onlin			

TABLE 2
SUMMARY STATISTICS

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)	16.80Non j 0 10.02 -10.02 0 218.46 284.34 610.						

TABLE 4
WEIGHTED ONLINE AND OFFLINE P

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				

Notes: "Low Price" is one of the four lowest prices offered for lens *i*; "High-Price" is one of the four highest prices offered for lens *i*.

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.

.

TABLE 7
REGRESSION RESULTS FOR LOG LENS PRICE

	Unweighted			Weighted		
	(1)	(2)	(3)	(4)	(5)	(6)
OFFLINE	0.251***	0.114***	-0.027	0.227***	0.058	-0.083
	(0.021)	(0.037)	(0.039)	(0.033)	(0.044)	(0.046)

TABLE 8

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 9

REGRESSION RESULTS FOR LOG LENS PRICE WITH ACUVUE INTERACTION

	Unweighted		Weighted	
	(1)	(2)	(3)	(4)
OFFLINE	0.290***	0.154***	0.269***	0.101**
	(0.027)	(0.340)	(0.043)	(0.50)
OFFLINE*ACUVUE	-0.137***	-0.132***	-0.144***	-0.139***
	(0.038)	(0.033)	(0.057)	(0.056)
EYESONLY		0.178***		0.178***
		(0.043)		(0.043)
INDEP		0.018		0.020
		(0.036)		(0.037)
CONSTANT	4.19***	4.20***	4.25***	4.25***
	(0.027)	(0.024)	(0.053)	(0.052)
R^2	0.84	0.86	0.81	0.83
F	149.03***	158.83***	90.03***	85.45***

Notes: N = 279. Unit of observation is the log of price of lens *i* at outlet *j*.

TABLE 10
REGRESSION RESULTS FOR TOTAL LENS PRICE

	(1)	(2)
OFFLINE	6.20** (3.24)	10.89*** (3.61)
OFFLINE*ACUVUE		-15.66*** (3.14)
EYESONLY	16.30*** (3.88)	16.23*** (3.87)
INDEP	4.00 (4.00)	