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Price Dispersion on the Internet: Good Firms and Bad Firms

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Abstract. Internet firms charge a wide range of prices for homogeneous products, and high-priced firms remain high-priced and low-priced firms remain low-priced over long periods. One explanation is that high-price firms are charging a premium for superior service. An alternative, price-dispersion explanation is that firms vary the prices for informed and uniformed consumers (Salop and Stiglitz, 1977) or serious shoppers and others (Wilde and Schwartz, 1979). The pricing pattern for a digital camera and a flatbed scanner is consistent with the price-dispersion model and inconsistent with the service-premium hypothesis.

I. Introduction

According to conventional wisdom, e-commerce markets provide efficiency unparalleled in traditional markets (Bakos, 1991). Many authors have argued that they these markets will eventually become competitive or will be typified by price differentials due to variations in service. Our results reject these views.

A typical discussion of Internet retailing starts with the observation that e-commerce has all of the characteristics associated with perfect competition. Consumers can compare many firms' prices with a click of a mouse, there are low barriers to entry, and firms can change prices at low cost (Bailey, 1998; Brynolfsson and Smith, 1999).

If indeed electronic markets were highly competitive we would expect at least one of three hypotheses to be true. First, we would expect to see the emergence of a perfectly competitive market where the *law of one price prevails*. Second, even if the market were not perfectly competitive, we would expect firms to adjust their prices regularly to undercut competitors, so that *firms' price-rankings vary over time*. Third, we would expect *a tradeoff between price and services or fees*, where firms that provide services, offer guarantees, or assess low shipping and other fees would charge higher prices to cover their extra costs. Using this latter reasoning, Varian (1999) predicted that two groups of e-commerce retailers will emerge: Those providing little service and low prices and those offering more

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service at higher prices. However, we find that none of these predictions holds in the Olympus C-2000Z digital camera and Hewlett-Packard 6300 flatbed scanner e-commerce retail markets.

Many of the early papers on electronic markets addressed the single-price hypothesis by reporting a substantial range of prices across Internet firms. Clemons et al. (1998) found that prices for airline tickets differed by an average of 20 percent among online travel agents even after controlling for product differentiation. Bailey (1998) noted that price dispersion in 1996 and 1997 was at least as great among the Internet firms as among the conventional outlets for books, CDs, and software. Brynjolfsson and Smith (1999) reported that the price differential for books sold on the Internet was greater than that in the conventional retail market. The dispersion of the posted prices (highest price minus lowest price divided by the average price) of book and CD prices on the Internet were 33 percent and 25 percent respectively. We find price dispersion in both the digital camera and scanner retail markets.

So far as we know, no previous study has examined the second hypothesis concerning price changes of e-retailers over time. We find that firms do not take turns undercutting each other. The price ranking of firms does not change much from week to week: High-price firms usually remain high-price firms over time.

Few studies have examined the third hypothesis. We show that these Internet retail markets for digital cameras and scanners consist of *good* firms that charge low prices and provide superior service and *bad* firms that charge high prices and provide poor service: the opposite of Varian's prediction. This pricing pattern is consistent with markets in which customers with high and low search costs pay different prices (Salop and Stiglitz, 1977).

Some consumers are sophisticated users of the Internet. They use *shopbots* – web sites that compare prices across firms (and often have information about shipping fees and whether the good is in stock) – to lower their search costs. These consumers know exactly which product they want and quickly and efficiently search for the lowest price. In contrast, other customers who are not sure which good to buy, don't know how to search efficiently for price, and put a very high value on their time may buy from one of the first sites they find. Consequently as in the Salop and Stiglitz (1977) model, some retailers set low prices and aim for the "informed" customers, while others try to induce "uninformed" consumers to buy from them at relatively high prices.

We start by discussing these and other theories of price variations in greater detail. Then, we describe our data. In the following section, we show that prices vary substantially and document that the price-rankings of firms are relatively constant over time. Next, we demonstrate that there are good firms (low price, good service or low fees) and bad firms (high price, poor service or high fees). Finally, we examine how firm quality rankings from at least one well-known Internet rating service vary with objective characteristics and discuss why some consumers may be relatively uninformed despite such services.

II. Theories of Price Dispersion

Several well-known theories explain why prices for a homogeneous good may vary across retailers. These theories can be loosely grouped into four categories. First, price dispersion may be random noise in an immature market that is slowly adjusting to the competitive equilibrium. Second, price variations across oligopolistic firms may be due to mixed strategies in pricing or other strategic behavior. Third, price dispersion may reflect service premiums. Fourth, price may vary as firms' price discriminate based on consumers' time-preferences or search costs.

1. Immature Markets

Brynjolfsson and Smith (1999) and others have argued that price dispersion may reflect the random noise of an immature market and that prices will converge over time. However, for the two products we study, the shape of the price distribution by week and the range or standard deviation of prices remained relatively constant throughout our sample period. Indeed, this price dispersion continued for well over a year. Thus, we view this theory as repudiated.

2. Oligopolistic Strategies

Several papers, such as Shilony (1977) and Varian (1980), presented static models in which oligopolistic sellers use mixed strategies in prices. For example, Varian demonstrated that a homogeneous-good oligopoly may set low ("sales") prices some times to attract customers who have low shopping costs. If the game is replicated independently over time, then the mixed strategies produce price variation over time. Firms cut prices solely to compete with rivals rather than to price discriminate. Firms are unlikely to have sales at the same times, and stores vary their pricing behavior over time.

We find no evidence of such sales during our sample period. We do not observe firms collectively raising or lowering prices randomly over time or individual firms taking turns undercutting each other.

Arnold (2000) demonstrated that price dispersion might occur even when all consumers have the same cost and prices are common knowledge if firms have inventory capacity constraints so that they run out of stock during periods of high demand.[1] Although consumers know the distribution of prices, they must incur a search cost to determine whether the good is in stock. Firms use pure strategies in prices, and buyers adopt symmetric mixed search strategies. It is not necessarily optimal for a firm to post a low price to attract additional buyers because buyer

[1] With search costs but no capacity constraints, Diamond (1971) illustrated that monopoly pricing may occur when all customers must incur even a small amount of search cost. Davis and Holt (1996) use laboratory experiments to show that search costs raise prices though not usually to the monopoly level (a result consistent with the theories of Perloff and Salop (1986) and Stahl (1989, 1996)).

concerns about a possible stock-out dampens buyer response to the low price.[2] During our sample period, digital camera retailers were out of stock 8 percent of the time, though only one scanner retailer ever ran out of stock. Moreover, determining whether some of these firms have the product in stock is time consuming. However, we do not find an obvious pattern between stock-outs and price.

3. SERVICE PREMIUM

Another common explanation for price dispersion on the Internet is product heterogeneity through bundling. Even if a good's physical product does not vary across stores, firms may provide different levels of service and bundle the product with other goods (Grilliches, 1961; Chow, 1967). Firms that provide services or have other attributes that build customer loyalty may charge premium prices. Again, Varian (1999) predicted that two groups of e-commerce retailers will emerge: those with low-service and low prices and those offering high service at high-cost. However, we show that a quite different pattern has emerged: good firms with low prices and superior service and bad firms with high prices and poor service.[3]

4. PRICE DISCRIMINATION

Price dispersion may reflect one of several forms of price discrimination. In some models, firms take advantage of differences in consumers' discount rates. In other models, firms charge ignorant consumers (those with relatively high search costs) and informed consumers different prices.

Nancy Stokey (1979, 1981) showed that, with a single consumer cohort with hetero-geneous tastes, it is optimal for a monopoly to market a new durable product by reducing the price over time so as to price discriminate temporally. The price of the digital camera does fall over time, which is consistent with her view of intertemporal price discrimination. However, this fall in price may be due to increased competition from other cameras. Moreover, we do not observe a downward trend in the other product we follow, scanners.

Similarly, Conlisk et al. (1984) and Sobel (1984) illustrated that price reductions for durable goods can be a means of price discriminating against consumers who are impatient and have relatively inelastic demands. A monopoly (or oligopoly) uses periodic sales to sweep consumers with relatively low reservation prices from the market. The rest of the time, the monopoly charges a higher price to consumers

[2] Arnold makes the potential testable prediction that firms that have lower than average prices are more profitable than those with above average prices. However, we have no information about the firms' profits.

[3] Analogously, Riesz (1979), Yamad and Ackerman (1984), and many others have shown that the correlation between price and quality is low. For example, Yamad and Ackerman report that the mean correlation across eight cameras in Japan is -0.04.

with higher reservation prices.[4] All stores may lower their price at the same time and to the same level. However, we observe price variation across firms within a period and not intertemporally.

Steve Salop (1977) showed that, if consumers have different costs to obtaining or processing information, some firms may sell at relatively high prices to only inefficient searchers while other firms would charge lower prices primarily to efficient searchers. Salop concluded that a monopoly facing consumers with varying search costs has an incentive to create spurious price dispersion ("noise") to segregate the market.[5]

Salop's static model may partially explain temporal Internet price dispersion. In our sample, several firms owned pairs of retail web sites. Some of these pairs of web sites posted the same price, but other pairs posted different prices or shipping fees. For example, e-Cost and PC Mall are both registered to "Creative Computers" of Torrence, California. In August of 2000, e-Cost set a price of $334.99 ($364.49 including shipping and handling) for a Hewlett Packard 6300 scanner, while PC Mall charged $399.99 ($418.22 including shipping and handling).

Though his model is static, Salop (1977) noted that varying the location of the low prices over time might be a feasible dynamic strategy. However, our data are consistent with the static and not the dynamic story: Prices vary across firms and not over time.

Salop and Stiglitz (1977) showed that firms might charge informed and uninformed consumers different prices. Their story is commonly referred to as the "tourists and the natives" model (Carlton and Perloff, 2000). In the simplest version of their model, some uninformed customers (tourists) have a positive cost of searching for the lowest-price firm, while informed consumers (natives) have no cost of search.[6] The uninformed buyers observe one price before they buy, while the informed buyers observe all prices. If enough consumers must incur search costs, it pays for some firms to charge a relatively high price and sell to only their portion of uninformed customers who choose between retailers randomly. Other firms charge a lower price (possibly marginal cost) and sell to both informed and uninformed consumers. Entry equalizes the profit between the two types of retailers.

Some other theories produce similar implications. For example, Wilde and Schwartz (1979) looked at discrimination that reflects differential consumer prefer-

[4] Salop and Stiglitz (1982) provide an alternative explanation for sales to sweep certain customers from the market. Stores price discriminate by holding (unannounced) sales to induce some (of the apparently homogeneous) consumers to purchase for future consumption.

[5] Similarly, Dana (1999) showed that when capacity is costly and prices are set in advance, firms facing uncertain demand will sell output at multiple prices and limit the quantity available at each price. Zettlemeyer (1998) showed that, if firms can set the search costs facing homogeneous consumers, firms may keep search costs high even if search costs could be lowered at no expense.

[6] Similarly, Burdett and Judd (1983) and Stahl (1989) assume that search costs are distributed across buyers, each of whom searches for low prices optimally.

ences for shopping. One could characterize a "shopper" as someone with a negative cost of search.

5. Conclusions about Theories

Casual observation of our data causes us to reject most of these theories out of hand. Consequently, we concentrate on the two remaining, opposing theories. The service premium theory suggests that high-service firms charge relatively high prices, whereas the Salop–Stiglitz price dispersion theory is consistent with high-service firms that charge relatively low prices and low-service firms that charge relatively high prices.

III. Data

Through extensive surfing on the Internet, we collected price and other information for the Olympus C-2000Z digital camera and for the Hewlett-Packard (HP) 6300 flatbed scanner. We picked popular models that many firms sell. We used the C/Net shopbot to identify a list of firms that sold these products. We followed 41 firms that sold the Olympus C2000Z camera and 28 firms that sold the HP 6300 scanner. We treated sites that were owned by the same firm and that charge the same price as a single site, but included as separate observations commonly owned sites that charge different prices.

Because the information in the shopbot was not always accurate (sometimes due to lags in updating), we collected data from each firm's web site weekly. The collection period lasted 14 weeks (September 24th to December 19th, 1999) for the camera and 11 weeks (October 7th to December 19th, 1999) for the scanner.[7] We rechecked the firms in August 2001 to see if the "bad" firms were more likely to go out of business; they were not. Out of 49 firms studied selling either product, 2 merged and 12 stop selling hardware. Of these 12, 7 had lower than average price and 5 had a higher than average price.

Along with the basic price (net of sales tax), we recorded shipping fees (to the same zip code as the retailer's address) and other fees and rebates. In addition, we collected answers to the following questions:[8]

- Did the firm offer a guarantee?

[7] The reason for the different lengths of observation is that we switched which flatbed scanner we followed three weeks after we started our study (as an older model was phased out). We were unable to continue collecting data after the periods mentioned because firms stopped selling these products.

[8] The academic literature rarely if ever notes that avoidance of sales taxes may contribute to price differences across firms for big-ticket items. A savvy consumer may reason: "If I buy a heavy durable on the Internet, I want it shipped from somewhere near but across the state's border so that I can avoid the state's sales tax". Thus, a Nevada-based store may be able to charge a higher price than those located in California and yet undercut Californian firms after fees and taxes are included. However, we cannot formally model this effect because we do not know the distribution of shoppers across states.

- Did the firm charge a fee for restocking the item? If so, how much?
- Did the retailer's website note whether the item was in stock? If so, was it in stock?
- Did the retailer specialize in selling certain types of products (e.g., did the retailer carry only photographic or electronic products)?
- What rating did the firm receive from Bizrate, a web site that posts detailed ratings of a number of Internet firms?[9]
- Did the website provide a photo of the product?
- Did the web page provide an extensive description?
- How many pages must one view when going from the firm's homepage to the product listing?

Table I presents summary statistics for our variables.

IV. Price Dispersion and Firm Rankings

We start by examining whether competition leads to a single price or constant jockeying of firms to have relatively low prices. We reject both of these hypotheses.

1. Price Distributions

We found that the prices of the camera and the scanner varied extensively, even among firms listed on the popular C/Net shopbot. Over our sample period, the total prices for the camera (including shipping and other fees) ranged from $673 to $1,015, with a mean of $808, as Table I shows.[10] The $342 price range was 42 percent of the average price. Figure 1 shows the histogram of prices over the sample period, which appears to be trimodal. The modes occurred at $90 intervals, at $720, $810, and $900. Approximately one quarter of the firms sold at prices less than $750 and a quarter posted prices great than $860. The shape of this distribution changed little over time, as the price distributions in most individual weeks were trimodal and the range of prices varied little (though the mean fell over time). When we again sampled the distribution ten months later, we did not detect major changes in the distribution.

Over the period, the range of total scanner prices, $106, was 29 percent of the mean price of $371. The distribution of the scanner prices in Figure 2 is bimodal, with one peak near the mean and a second mode at the upper end of the range. Again, the shape of this distribution did not change much from week to week over the sample period.

[9] We used the Bizrate rankings because the other rating sites we found, such as Gomez, ranked substantially fewer of these firms than did Bizrate. Bizrate rated virtually all the firms in our sample that were rated by Gomez and others as well.

[10] Since we limited our observations to firms posting information on a single shopbot, out data do not include all Internet retailers. Thus, the actual dispersion in prices is greater than what we report.

Table I. Means, (standard deviations), minimums, and maximums

	Olympus C-2000Z Digital Camera			HP 6300 Flatbed Scanner		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum
Continuous Variables						
Price ($)	797.77	663.01	999.95	357.29	309.95	402.99
	(71.04)			(21.25)		
Total price ($)	808.23	672.96	1,014.90	371.40	315.17	421.43
	(68.49)			(22.73)		
Shipping fee ($)	9.65	0	29.00	12.68	0	34.29
	(7.84)			(7.95)		
Restocking fee (%)	8.76	0	20	10.69	0	20
	(7.17)			(6.93)		
Other fees ($)	1.14	0	17.52	1.09	0	13.60
	(3.79)			(3.09)		
Bizrate (0 to 5 stars; 0	1.96	0	4.5	2.32	0	4.5
means not rated)	(2.04)			(2.03)		
Bizrate (>0 to 5 stars)	4.03	2.5	4.5	3.98	2.5	4.5
	(0.19)			(0.24)		
Pages between home and	2.71	1	5	2.93	0	9
product page	(1.17)			(1.73)		
Binary Variables						
Camera firm	0.05			–		
Electronic firm	0.64			0.71		
No Bizrate rating	0.51			0.42		
4.5 Bizrate stars	0.12			0.18		
Guarantee	0.71			0.85		
Out of stock	0.08			0.01		
Stocking not reported	0.33			0.27		
Photo of product	0.59			0.40		
Minimal description	0.22			0.42		
No phone number listed	0.10			0.11		
Accessories listed	0.26			–		
>3 pages to product page	0.22			0.29		
Need name search to	0.23			0.14		
find product's page						
Number of observations		574			306	

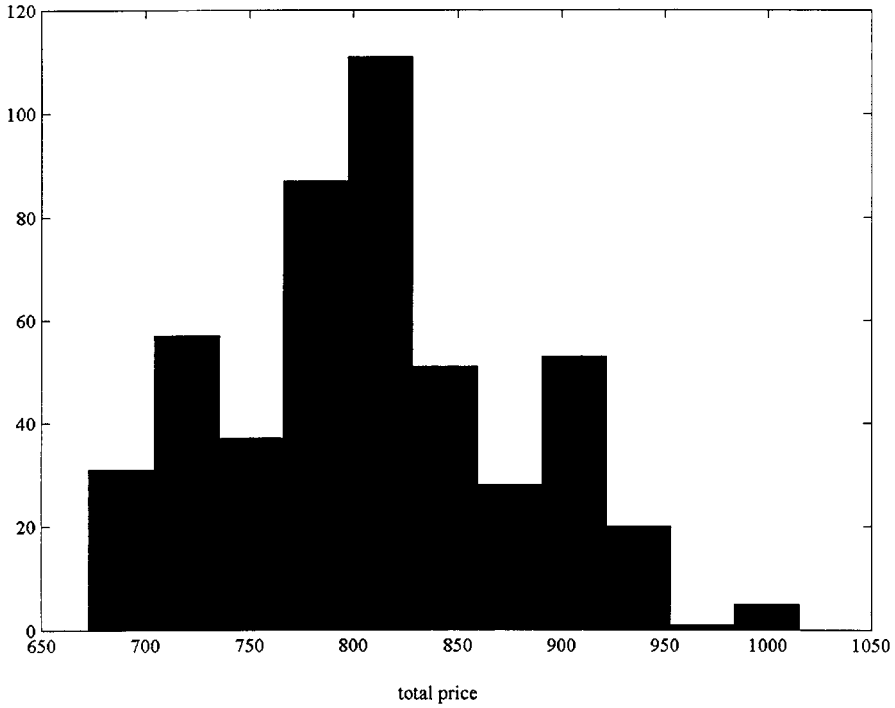

Figure 1. Histogram of camera prices over 14 weeks.

Firms frequently changed their prices. Camera vendors changed their posted prices roughly every three and a half weeks, while scanner sellers adjusted their posted prices about every four and a half weeks. Given that the cost of adjusting prices is very low and firms did so frequently, we might expect vigorous price competition, especially if consumers have full information. However, we found no evidence that prices were converging to a mass point, as the distributions remained essentially constant over time.

2. Firms' Price-Rank Ordering

Even though the law of one-price fails, we might expect that the ordering of the firms by price would change frequently as firms tried to undercut rivals. To test this hypothesis, we examine whether the price-rank ordering of firms is random or whether stores tend to maintain their ranks over many weeks.

We order the firms from low to high using total price (which includes shipping and other fees). The matrices in Figures 3 and 4 show the week-to-week changes in rank for cameras and scanners. Row i of each matrix shows a firm's rank in week i, while column $i + 1$ reflects the firm's rank in the following week $i + 1$. If the price orderings in a week were purely random (and, in particular, independent of the order in previous weeks), the shift from a rank in week i to any other rank in the

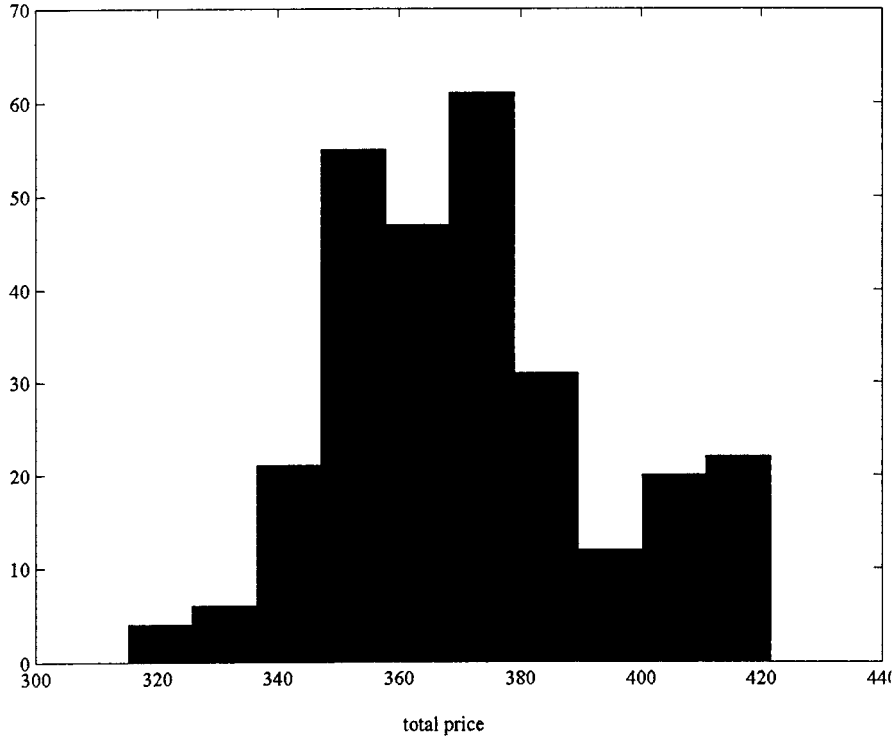

Figure 2. Histogram of scanner prices over 11 weeks.

following week would be equally likely. Consequently, the probability of being in any cell in the matrix would be the equal. However, major changes in rank ordering are rare so that most of the weight lies along the principal diagonal of the matrix.

We do not report formal statistical tests because the results are obvious upon inspection. As Figure 3 shows, a camera retailer with a given rank in week i maintained the same rank the following week 25 percent of the time. A firm kept its rank or changed its rank by at most one position 57 percent of the time. A firm changed more than 10 ranks (out of a possible 40) only 4 percent of the time. Figure 4 shows that scanner vendors did not switch rank 37 percent of the time, changed by at most 1 rank 75 percent of the time, and moved more than 10 (out of a possible 27) ranks only 1 percent of the time.

Even over much longer periods, firms maintain their rank. Comparing the ranks of the scanners in the last week of our sample to the ranks 10 months later, 40 percent changed 1 rank or less, and no firm changed by more than 10 ranks.

This consistent ordering of firms is incompatible with the hypotheses that price dispersion reflects an immature market that is adjusting toward a competitive market or that firms hold irregular price promotions or systematically cut prices to take sales from rivals. Thus, our remaining principal hypotheses are that high-price

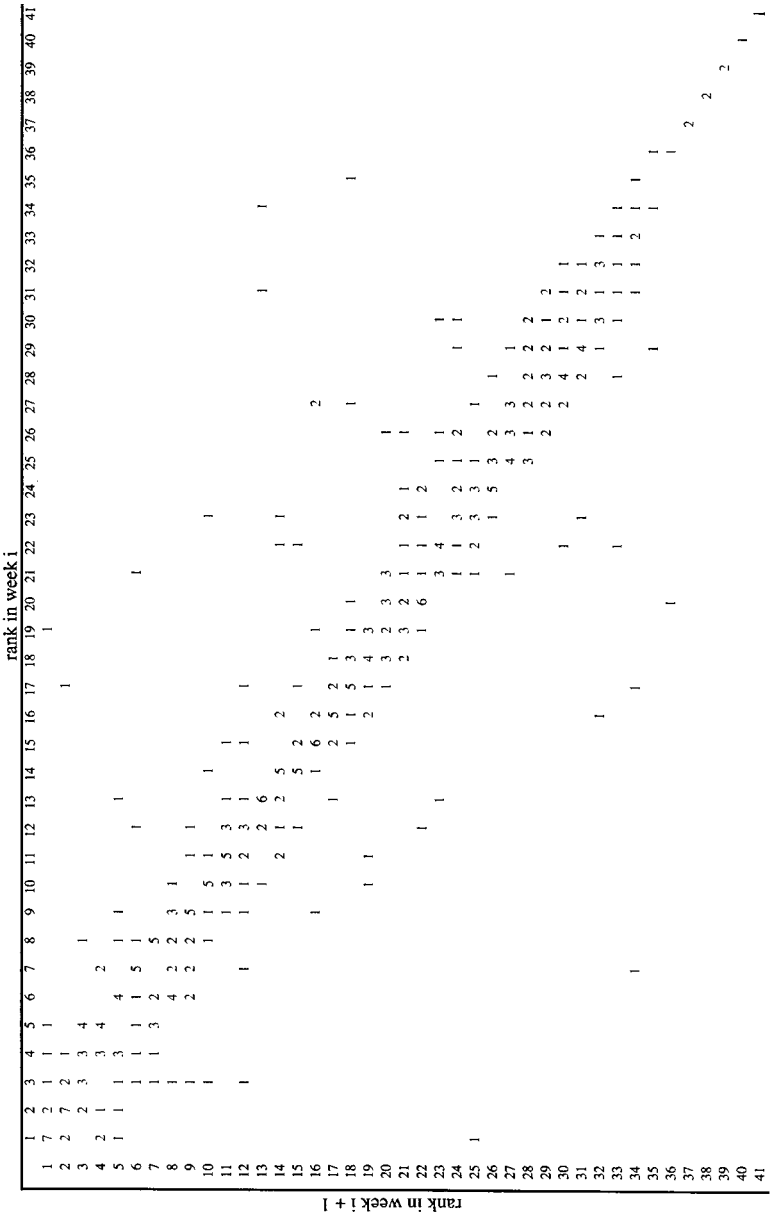

Figure 3. Price-rank of camera vendor in week i versus week $i + 1$.

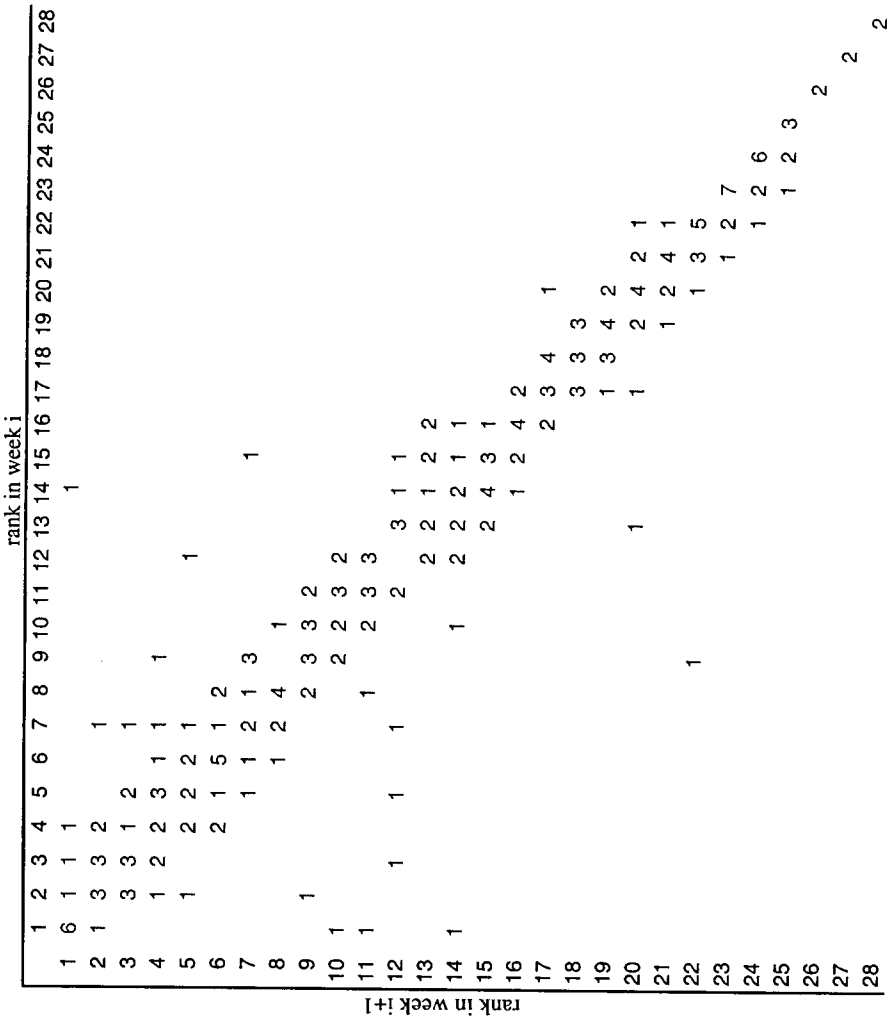

Figure 4. Price-rank of scanner vendors in week i versus week $i+1$.

firms charge a premium for services or that firms engage in some form of price discrimination or Salop–Stiglitz price dispersion.

V. Pricing Model

Given that both high-price and low-price firms maintain their relative price position over long periods, why do some firms consistently charge higher prices than others? Can this price dispersion be explained by firms taking account of different degrees of consumer information (or other similar explanations) or by firms charging a premium for service?

To distinguish between the price-discrimination and the service-premium hypotheses, we regress each firm's price on various firm characteristics, shipping and other fees, and time dummies. Table II shows the camera and scanner regressions, where we correct for first-order autocorrelation (dropping the initial observation for each firm). For the three continuous variables, shipping fee, restocking fees, and other fees, we include level and squared terms (higher-order terms were statistically insignificant). We use nominal prices because our sample period is relatively brief. We do not include firm-specific dummies because many firm dummies would be perfectly collinear with dummies representing firm characteristics.

To save space, the table does not report the time dummy coefficients. There was a pronounced drop in the camera price over the sample period.[11] However, no clear pattern emerged for the scanner.[12]

If the service-premium story were correct, firms would set higher prices if they offered guarantees and charged low shipping and other fees. Alternatively, if the Salop–Stiglitz model applies, firms with these desirable attributes would charge less, as they tried to attract informed consumers.

Buyers like the security of a return guarantee (the unconditional ability to return the good for a refund) and no restocking fee (a percentage of the purchase price that is forfeited if the good is returned). If all buyers were sophisticated and had low search costs, we would expect firms to raise their price to cover their extra costs if they provide a guarantee and waive a restocking fee. However, in the actual world of both sophisticated and unsophisticated shoppers with varying search costs, this tradeoff does not occur. Good firms charge low prices and provide consumers with security while bad firms charge high price and fail to provide guarantees. Firms

[11] In the camera equation, the coefficients on the week dummies from week 2 through week 14 (where week 1 is the residual period) were −7.831 (t-statistic = −1.49), −6.146 (−0.89), −5.501 (−0.68), −12.86 (−1.52), −12.07 (−1.41), −20.71 (−2.34), −29.51 (−3.22), −34.47 (−3.80), −36.69 (−4.12), −44.93 (−5.11), −39.29 (−4.89), −31.19 (−4.64), and −29.30 (−5.34). The time pattern for camera prices could reflect price discrimination by the manufacturer based on individuals' time preferences (Stokey, 1979). Alternatively, it could reflect increased competition from rival manufacturers or technological progress.

[12] In the scanner equation, the coefficients on the week dummies for week 2 through week 11 were 1.38 (0.84), −1.07 (−0.49), 0.37 (0.15), −0.28 (−0.10), −1.55 (−0.53), 0.97 (0.33), 0.71 (0.25), 7.25 (2.77), 9.35 (4.07), and 7.42 (4.06).

Table II. Linear regression on total price

	Olympus C-2000Z Digital Camera		HP6300 Flatbed Scanner	
	Coefficient	*t*-statistic	Coefficient	*t*-statistic
Returns				
Guarantee	−41.52	−3.73	−21.71	−1.75
Restocking fee	−2.23	−0.77	1.28	0.78
Restocking fee^2	0.18	1.05	−0.11	−1.08
Fees				
Shipping fee	0.80	0.31	5.06	4.59
Shipping fee^2	−0.15	−1.63	−0.14	−3.94
Other fees	3.43	0.55	10.86	3.64
Other fees^2	−0.73	−1.91	−0.54	−2.18
Stocking				
Out of stock	−1.42	−0.25		
No information	−4.96	−0.99	6.02	2.46
Type of Firm				
Camera store	−30.79	−1.47		
Electronics store	−27.71	−2.96	12.62	2.13
No Bizrate rating	16.34	1.51	−18.51	−3.12
4.5 Bizrate stars	24.37	1.59	−16.26	−2.47
Website				
Photo of product	36.36	2.94	18.36	3.42
Minimal description	12.11	0.89	12.75	2.40
No phone number listed	−9.11	−0.43	4.40	0.45
Accessories listed	18.99	1.63		
>3 pages to product page	−48.25	−4.22	8.16	1.14
Need name search to find product's page	−14.30	1.36	3.01	0.48
Constant	871.17	37.89	338.93	16.43
ρ	0.79	27.68	0.93	37.17
D.W.	2.12		2.13	
R^2	0.81		0.88	
Number of observations	466		233	

that provide a guarantee charge $42 less for a camera and $25 less for a scanner (marginally statistically significant). Thus, this effect is consistent with the price-discrimination hypothesis rather than the service-premium hypothesis.

If only informed consumers populated the world, we would expect to see a service premium reflected in price: A firm that charged higher fees would set a lower price so that the total price remained constant. Instead, we find a quadratic relationship between shipping fees and total price. For both the camera and the scanner, the coefficients on the shipping fee and fee squared are collectively statistically different from zero (F-statistic = 6.32 and 13.22 respectively), though the coefficients are not individually statistically significantly different than zero in the camera equation.

The effect of an extra dollar of shipping fees on the total price for the scanner is increasing until the shipping fee reaches $18.07 and is positive through the observed range of fees. A firm that charged the average shipping fee of $12.68, sets a total price that is $41.65 more than does a firm that charges no shipping fee.

The price effect of an extra dollar of shipping fees for the digital camera increases until the shipping fee reaches $2.67 and is positive until the fee reaches $5.33. A camera vendor that charges the average shipping fee of $9.65, sets a total price that is $6.25 less than a firm that charges no shipping fee.

The "other fees" are lump-sum handling or mandatory membership fees. Many of the firms that use such fees employ a particularly sleazy practice: The buyer discovers that these fees are assessed only after spending substantial time filling out all the forms for ordering the product. Consequently, we hypothesized that these fees were more likely to be charged by firms catering to unsophisticated customers. Of firms that collect such a fee, the average fee was $11.66 for cameras and $7.61 for scanners. Because most firms did not charge these other fees (only 4 of the 41 camera firms and 4 of the 28 scanner firms charged such a fee), the average fee across all firms was only $1.14 for cameras and $1.09 scanners.

Again, we find that the price effect of these fees is quadratic. Collectively, the coefficients on the other fees were significant for both the camera and the scanner (F-statistic = 12.23 and 11.50 respectively). Scanner vendors that charge these fees set a higher total price (for the entire range of observed fees). At a fee of $10.06 (where the effect is maximum), the store's total price is $54.65 more than a store that does not set such a fee. These fees have a positive effect on total price until the other fees reach $20.12. For the camera, the price effect of an increase in a dollar of other fees is increasing until the fee reaches $2.35 and is positive until the fee reaches $4.70. These results are consistent with the price-discrimination story and not with the service-premium story.

Because not reporting whether the product is in stock is a careless or sleazy practice, we predicted that such firms would charge more, which is consistent with the price-discrimination model and not with the service-premium story. Firms that do not report whether the product was in stock charged a statistically significant

$6.02 more for a scanner but not statistically significantly more for a camera than do other firms.

We also included an "out-of-stock dummy" because we thought that firms that reported the good was out of stock might charge less to induce customers to wait. However, the coefficient on this dummy variable was not statistically different from zero at the 5 percent level in the camera equation. We left this dummy out of the scanner equation because only one firm ran out of stock (twice) during our observation period.

Some web sites appear to be designed to make searching costly. One explanation is bad design (poor service). Another is that the site selects for those customers with low-search costs or little time preference. Such a practice makes sense if the firm charges those customers a low price and charges a higher price at another site that is easier to search. A typical site's home page has a list of products. By choosing "cameras" and then making sequential choices, one eventually arrives at the Olympus C-2000Z Digital Camera page. To get to this page requires going through one to five pages depending on the site. For the scanner, one views between zero and nine pages. On sites where it takes more than three pages to get to the desired product from the home page, firms charge $48.25 less for the camera (this variable was not statistically significant for the scanner).[13] This differential may reflect price discrimination over consumers with different time preferences. Clemons et al. (1998) found similar results for travel agents.

The retailers tended to provide either a photo or a detailed description of the product, but rarely both. Presumably those consumers who know the quality characteristics they prefer find the write-up is more useful. Perhaps other customers who are less certain which product characteristics they like may be more influenced by a photo. If the website had a photo of the product, the firm charged a $36.36 higher total price for the camera and $18.36 more for the scanner. Firms that provide only minimal descriptions about a product (no more than five lines of text) charge $12.75 more for a scanner (the result was not significant for the camera at the 5 percent level).

Firms specializing in electronics charge $27.71 less for the camera and $12.62 more for the scanner than do non-specialized firms. The accessory dummy (equals one if camera accessories are listed on the camera product page) and the phone number dummy (equals one if the firm's phone number is listed on the web site) were not statistically significant at the 5 percent level.

Several web sites, such as Bizrate, rate vendors. Bizrate relies primarily on consumers for ratings, but its staff rates some firms (consumers rated 20 out of our 23 rated firms). Bizrate asks consumers to fill out its survey immediately after making a purchase and then after delivery. The questionnaire covers 10 categories: ease of ordering, product selection, product information, price, website, on-time

[13] At some sites, you can only find the product by using a site-specific search engine and providing an exact name. However, a variable capturing this effect was not statistically significantly different from zero in either equation.

delivery, product representation, customer support, privacy policies, and shipping and handling. At the time of our study, a consumer gave each firm between one and five stars for each category, and the results were then averaged to give an overall score. As a practical matter, we observed ratings from 2.5 to 4.5 stars. One camera store and one scanner store received 2.5 stars; one had 3.5 stars; fourteen camera firms and nine scanner vendors had 4 stars; and five were awarded 4.5 stars. Because very few firms had 3.5 stars or fewer, we combined them into a category with those that scored 4 (our residual category). The other two categories are unrated firms and those that got the top observed score of 4.5 stars.

We find no statistically significant effect of the ratings on camera prices. However, scanner prices are up to $18.50 lower if a firm is unrated or has a high rating rather than a relatively low rating. This result is not consistent with the service-premium story but may be with the Salop–Stiglitz model.[14]

VI. Price and Quality Rankings

According to the Salop–Stiglitz theory, one way to reduce price dispersion is to provide uninformed consumers with information. If so, why doesn't information about relative prices (C/Net and other shopbots) and quality ratings (Bizrate, Gomez, and others) drive high-price, low-service firms out of the market?

One explanation is that many consumers are unaware of these services or otherwise unwilling to use them. After all, it's difficult for consumers to judge the objectivity and reliability of price and stocking information as well as quality ratings and other information freely provided on the Internet. We found that most of the shopbots were not completely reliable in their listings of objective statistics such as prices, shipping fees, and whether the product was in stock. None listed a very large proportion of all relevant retailers on the Internet.

One could argue that the shopbots provide consumers with the "market distribution" of prices. Salop and Stiglitz (1977) and many of the papers discussed earlier presume that consumers know the distribution but not which firm has the lowest price (cf. Stahl, 1996).

The reliability of less objective quality ratings is even more questionable. We used binary probit (Bizrate rating is 4.5 or another positive number) and ordered probit (Bizrate rating is 4.5, 4.0, or another positive number) to determine how the Bizrate ratings are related to our relatively objective firm characteristics. We included only one observation per firm because none of the firms' characteristics changed over our sample period except for price and fees. Because our camera

[14] The Salop–Stiglitz model predicts that lower-priced firms have larger market shares. We do not observe sales of digital cameras or scanners directly. However, we know how many customers ranked a retailer for Bizrate. These numbers are a proxy for the retailers' sales. In our sample, relatively low-price firms did not have more Bizrate responses. Of course, the number of responses also depends on the number of products each retailer carries as well as the sales of each. Moreover, high-volume firms (e.g., Buy.com) may engage in heavy marketing that offsets the price effect.

and scanner sample sizes are small, we combined the samples. To make our price and fee variables comparable across the two markets, we used the ratio of the firm's average price during the period to the average price for the product over this period. For the few firms that sold both products, this ratio was within 5 percent in both markets. For those firms, we averaged the two ratios. (The price variable we use measures the price of only the camera or the scanner, whereas Bizrate presumably considers prices across many goods in ranking a vendor.) We dropped the out-of-stock variable because no firm was out of stock for the majority of the time, and we omitted the no-phone-listing variable because it was highly correlated with the other dummy variables.

None of our variables was statistically significantly different from zero at even the 0.10 level (indeed, all of the z values were less than 1.0). Consequently, we do not report these results in a table. Given that our variables overlap several of Bizrate's categories, these results are surprising. Perhaps Bizrate's consumers provide largely random information, in which case the ratings are worthless. Alternatively, our lack of predictive power may result from Bizrate putting substantial weight on product selection, privacy, support, and delivery (categories we do not include), in which case the ratings contain information beyond that from our other variables.

As discussed above, the Bizrate rating is not highly correlated with the camera price, but has a statistically significant impact on scanner prices. One possible interpretation of this result is that consumers who buy cameras for recreational use are relatively unlikely to search for and use the ratings of others, unlike people who buy scanners for business use.

Given that even the pricing information of the shopbots is not completely reliable and the rankings of firms like Bizrate may be questionable, we conclude that Internet consumers must spend substantial time and effort to gain "full information".[15] It may take 10 to 15 minutes or more per site to obtain all the relevant information. If Arnold's (2000) model applies, the key issue consumers must check is whether the product is in stock. Determining whether the product is in stock and whether fixed fees are assessed is particularly time consuming, as one may need to complete the ordering process (filling out many forms) before the site supplies this information. It takes consumers even longer to evaluate a firm if they want to check the firm at several rating services.

VII. Summary

Many have predicted that the advent of Internet retailing would result in a perfectly competitive market with a single equilibrium price for a homogeneous product. However, Internet firms charge a wide range of prices for a homogeneous product,

[15] Some purchasers (especially of scanners) may question the reliability or relevance of the Bizrate ratings because they are based on the opinions of self-selected consumer who presumably have low opportunity costs of time.

as we find for a specific digital camera and a flatbed scanner (and other studies have found for many other goods).

Unlike previous studies, we examine how Internet prices change over time. Even if the law of one price is violated, one might expect Internet firms to compete to undercut each other, so that the rankings of firms by price would vary over time. This hypothesis is false in our two markets: High-priced firms remain high-priced and low-priced firms remain low-priced over long periods. Moreover, prices do not fluctuate over time in a manner that would suggest that e-retailers use periodic sales.

We consider two alternative explanations for price dispersion. The service-premium model contends that some retailers provide better services that allow them to charge more. Our alternative hypothesis is based on the Salop and Stiglitz (1977) model of price differences across informed and uniformed consumers. Essentially, we examine whether firms charge a higher price to consumers who desire services or to those who are ignorant.

We conclude that the evidence from our two markets is generally consistent with the Salop–Stiglitz model and inconsistent with the service-premium story. For example, firms that use consumer-unfriendly practices – such as not allowing returns or not indicating whether the – good is in stock – tend to charge higher prices. We also provide other evidence consistent with the price-discrimination hypothesis.

We conclude that the e-retailing market is characterized by significant search costs (collecting information takes up to 15 minutes or more per site on some of the less user-friendly sites), especially to determine whether a good is in stock and, to a lesser degree, its price. These transaction costs result in price dispersion possibly because firms discriminate among consumers based on their knowledge, search costs, or patience (Salop and Stiglitz, 1977; Wilde and Schwartz, 1979).

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