PRICES REFLECT VENDOR DIFFERENCES:
THE CASE OF HANDHELD COMPUTERS ON CNET

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Abstract

Shoppers who use the Internet can often find multiple vendors of a single, physically identical product. These vendors may offer very different prices for these identical products. However, different vendors may or may not be certified or rated by third parties, be familiar to the shopper due to advertising, or have offered "free" shipping. This research investigates whether product prices reflect vendor differences. This research shows that consumers do, to some extent, get what they pay for, since higher prices are demanded by vendors who advertise, offer free shipping, or are highly rated.

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Introduction

Since Hotelling (1929), theorists have paid close attention to the physical location of business outlets. The fields of urban planning, economic development, and urban economics find spatial location theory to be indispensable. In addition, traditional firms find the logic of Hotelling's linear city to be second nature in choosing a physical location. Hotelling begins with the assumption that consumers choose to buy from the closest firm, then introduces realistic complications, such as the fact that offering a lower price can compensate the consumer for travel costs. Scholars following Hotelling have added numerous refinements to and variations on the linear city model (Eaton and Lipsey, 1975; d'Aspremont; Gabszewicz, and Thisse, 1979; DePalma, et al., 1985; Economides, 1986; and Dasgupta and Maskin, 1986).

A firm's physical location matters little in ecommerce. A convenient online location can be as elusively trivial as having a memorable URL. Locating near another ecommerce firm can be as straightforward as advertising on the firm's page. However, Hotelling's linear city has also been used to model more than physical location. The concept of "marketing niches" may be

formalized by the linear city model, as noted by Tirole (1990, p. 286, note 11). Firms may choose dimensions of sweetness for foods, user friendliness for computer software products, or degree of technical support for vendors of high-tech products.

Since physical location is trivialized by ecommerce, firms who wish to maintain profit margins must find other dimensions on which to differentiate their products, as discussed by Scott and Miller (2001). Immediate customer contact is reduced by ecommerce; hence, hence firms may find it important to demonstrate that their claims of differentiation from other firms are real through increased use of third party certifications, warrantees, and ratings. The presence of third party certifications, warrantees, or high ratings should enable firms to charge higher prices.

Scott and Miller, consistent with long traditions in marketing and economics, also note that advertising may differentiate vendors in the minds of consumers. In ecommerce, advertising not only builds brand identity and provides information, but also lowers the transactions cost of shopping, since buying from advertisers on shopping sites is easier than buying from non-advertisers. Hence, advertising on multi-vendor shopping sites is expected to be associated with higher prices, other things equal. In addition, Scott and Miller discuss differentiation through reducing transactions cost risk. One example of transactions cost risk reduction that firms sometimes undertake is a commitment to provide free shipping. Firms who do not commit to provide free shipping increase customer transactions cost risk because online shoppers are often informed of shipping costs only after they have expended most of their shopping effort. With free shipping, the customer is informed, up front, how much the eventual charge to the credit card will be. Since specifying free shipping reduces customer risk, Scott and Miller hypothesized that firms who offer this benefit would compensate by charging higher prices for their products, offering customers a simple risk/return tradeoff.

This research is based on Scott and Miller's application of Hotelling's linear city to ecommerce. Where Scott and Miller explain the theory of spatial competition and apply the theory to ecommerce markets, this study will empirically test the theory. In particular, this research examines prices that vendors charge for six models of handheld computers offered on CNET's (http://www.computers.com) shopping site, performing tests of whether these prices depend on a third party warranty/certification, a separate third party rating, advertising on the site, and a free shipping committment. A generalized least squares treatment of panel data, specifically two-way random effects, is used to derive estimates of the effects of vendor differences on the price and to test for significance of these effects. In the following section, the data is discussed. In the third section, the empirical model is explained. The fourth section anticipates the results of the estimation. The fifth section contains the results of the estimation. Finally, conclusions are offered and directions for future research are given.

Data

Data were collected during the week of September 10, 2001 from CNET's web site (http://www.computers.com) on six handheld computers: the Casio Cassiopeia E125, Compaq Ipaq H3650, the Palm M500, the Palm M505, the Palm Vx, and the Sony CLIE PEG-N710C. The particular handheld models were chosen with consideration for the following criteria. First, because of concerns for sample size, the number of vendors of each handheld was considered.

No Handspring product had more than twenty vendors during the sample period, so no Handspring product is included. Second, variety was considered. Third, market share was considered.   This is why three Palm products and one non-Palm product that uses the Palm OS (the Sony) was selected. This sample selection yielded enough information to derive reliable estimates of the parameters of the statistical model.

Descriptive statistics on the sample, including prices, are given in Table 1. The average handheld model had 39.6 vendors, for a total of 198 price observations over the six models. The Palm Vx had the lowest mean price ($249.20), while the Compaq Ipaq had the highest mean price ($471.98). The price ranges of individual models across vendors varied from around $80 (on the Sony CLIE) to around $190 (on the Cassiopeia). The handhelds' price ranges overlapped with each other across vendors. For instance, though the Palm M505 is more advanced than the Palm M500, one can find a vendor who sells the advanced Palm M505 for less than the highest priced vendor of the M500.

Descriptive statistics on the explanatory variables are given in Table 2. The explanatory variables that are used to explain price variations are as follows. The Gomez Rating variable is the number of stars in the vendor's Gomez rating. The Gomez rating criteria are given in Appendix A. Only rated vendors are included in calculating this average, though both rated and non-rated vendors are used in this study. The Gomez rating varies from a low of zero stars to a high of three stars. In the data analysis, we used a zero if the company was not rated, which carries an implicit assumption that if the customer sees no rating, the customer assumes the lowest rating. The average rated Gomez vendor had a rating in excess of 2.6 stars. This high average makes sense because firms will only ask to be rated if they know their rating will be somewhat high. About seventy percent of the vendors of the different models in our sample were rated by Gomez. This varied slightly by handheld model. The Gomez Rated variable, the proportion of firms rated by Gomez, is presented in Table 2, but is only used in describing the data, not in analysis of the data.

The Advertise variable measures whether or not the vendor had a graphical advertisement on CNET's site during the survey period. This varied from three percent for vendors of the Cassiopeia up to thirteen percent for the Sony CLIE. The Free Shipping variable is dichotomous, measuring whether the vendor posted that shipping was free. About ten percent of vendors advertise free shipping. The CNET Certified variable is dichotomous, measuring whether the vendor is a CNET Certified Store. The criteria for being a CNET Certified Store are given in Appendix B. Each handheld model had between seventy and eighty-five percent of vendors who were CNET Certified Stores.

Statistical Model

The data may be grouped in two ways. First, there are multiple vendors of each handheld model. One vendor's price of the Compaq Ipaq likely has a great deal in common with another vendor's price of the Ipaq. Second, some price observations across models are common to one vendor. For instance, Computers4Sure sells both the Compaq Ipaq and the Palm Vx. Computers4Sure's pricing decisions on the different models that it sells likely have a great deal in common with each other.

This description of the data leads to a choice of the two-way random effects technique. The two effects that cause observations to be similar are vendor and handheld model. Given these two effects, this model could be estimated assuming either that the effects are correlated with the independent variables (fixed effects) or that they are uncorrelated with the independent variables (random effects). Both techniques are variants of generalized least squares--like ordinary least squares, but with a non-standard variance-covariance matrix. There is no theoretical reason to suspect that the two effects in this model are correlated with the independent variables, so the random effects model is used. Once the random effects estimators are obtained, the correlation between the estimated effects and the independent variables will be statistically tested.

Hence, we model the price of the *ith* handheld which is sold by the *jth* vendor as

$$Price_{ij} = B_0 + B_1*Advertising_{ij} + B_2*Gomez\ Rating_{ij} + \qquad\qquad (1)$$
$$B_3*CNET\ Certification_{ij} + B_4*Free\ Shipping_{ij} + \lambda_i + \mu_j + e_{ij}.\ \ i = 1, \ldots, 6; j = 1, \ldots, V_i.$$

Where the i subscript denotes the handheld model, and the j subscript denotes the vendor. λ_i is the effect that handheld model i has on the price. μ_j is the effect that vendor j has on the price. e_{ij} is the error term. In the random effects model, λ_i and μ_j are estimated. V_i is the number of vendors of handheld i. This two-way random effects model assumes that the vendor and firm effects have a mean of zero, constant variance, and that the two effects are uncorrelated with each other and the error term. That is, using E[˙] as the expected value operator, $E[\lambda_i] = 0$, $E[\mu_j]$ = 0, $E[\mu_j^2] = \sigma_\mu^2$, $E[\lambda_i] = \sigma_\lambda^2$, $E[\mu_i, \mu_j] = 0$ for
$i \neq j$, $E[\lambda_i, \lambda_j] = 0$ for $i \neq j$; and λ_i, μ_j, and e_{ij} are uncorrelated for all i and j.

As previously stated, the two-way random effects model is a generalized least squares (GLS) estimator. The GLS model differs from ordinary least squares (OLS) because, rather than assume zero covariance between errors, the variance-covariance matrix of the errors is estimated in a first step, then used in the second step to derive the final estimates. The first step of the two-way random effects model, deriving the variance-covariance matrix of the error, is performed by two regressions--one regression of the dependent variable on dummy variables representing the handheld model and one regression of the dependent variable on dummy variables representing the vendor. The errors from these two regressions are used to derive the variance-covariance matrix which will be used in the second step. In the second step, the model in equation (1) is estimated using least squares, but relying on the variance-covariance estimates from the first step. The estimates that are derived are consistent; that is, the estimators' distributions are asymptotically unbiased and asymptotically approach the normal distribution. Hence, the standard normal distribution is used for statistical inference.

The appropriateness of the model may be tested in two ways. First, Breusch and Pagan's (1980) Lagrange multiplier statistic is used to test whether the GLS two-way random effects model is significantly different than an OLS model which does not have group effects included. Breuch and Pagan's Lagrange multiplier statistic for the two-way random effects model is distributed as a chi-square with two degrees of freedom. A high value of the chi-squared test statistic causes one to reject the null hypothesis that the random effects model is statistically no different than the OLS model. Second, Hausman's (1978) chi-squared statistic tests whether the two effects,

handheld model and vendor, are correlated with the independent variables (i.e. are there fixed effects). The null hypothesis for the Hausman test is that the model has <u>no</u> fixed effects. Since there is no theoretical for assuming that the two effects are correlated with the independent variables, we expect to fail to reject the null hypothesis using the Hausman test.

Expected Results

Firms that pay the price of advertising on CNET are expected to charge higher prices; else, advertising would be, by the firms' own actions, financially irrational. Thus, the coefficient of the Advertising variable is expected to be positive. The size of the Advertising coefficient reveals how many extra dollars that a firm marks up its price if it has a CNET advertisement, other things equal. The size of the Gomez Rating coefficient reveals how many extra dollars that a firm marks up its price if it has another star in the Gomez Rating scheme (there are a maximum of three stars). Firms with a higher level of service are expected to be able to charge higher prices; hence, we expect the Gomez Rating variable's coefficient to be positive. CNET Certified Stores are expected to be able to charge higher prices since they provide a higher level of service and CNET provides a limited warranty that these companies will not abuse the customers' credit cards. The CNET Certification coefficient is expected to be positive. The size of the CNET Certification coefficient reveals how many extra dollars that CNET Certified Stores charge for their product. Vendors who state up-front that shipping is free are able to lower the customer's risk of choosing their product as opposed to a lower priced product because the customer may be surprised to find high shipping charges after incurring most of the transactions cost of purchasing. Thus, the Free Shipping coefficient is expected to be positive.

The use of the random effects model is consistent with a high value for Breusch and Pagan's Lagrange multiplier statistic, which would indicate that the random effects are significant restrictions on the model. Further, a low value for Hausman's chi-squared is expected, leading to a failure to reject the null hypothesis of <u>no</u> fixed effects.

Empirical Estimation

The results of our two-way random effects model are given in Table 3. The estimate of equation (1) are:

$$\text{Est. Price}_{ij} = 373.32 + 23.11*\text{Advertising}_{ij} + 5.22*\text{Gomez Rating}_{ij} + \qquad (2)$$
$$7.67*\text{CNET Certification}_{ij} + 29.91*\text{Free Shipping}_{ij}$$

Firms that have a graphical advertisement on CNET, other things equal, charge prices that are $23.11 higher than firms that do not have a graphical advertisement. The P-value of 0.017 indicates that this coefficient is significantly different than zero at the .05 level of significance. The primary reason that advertisements might significantly increase the price is that the vendors that display advertisements are listed first; however, graphical advertisements may be also important for their attractive quality. This large increase in gross margin is expected to justify the cost of the advertisement.

The Gomez Rating increases the price of a handheld by $5.22 per star. Since there are a maximum of three stars, the difference between not being rated and being rated at 3 stars is 3*$5.22 = $15.66. The Gomez Rating's coefficient's P-value of 0.031indicates that the coefficient is significantly different than zero at the .05 level of significance. Gomez does not charge for its rating service, but firms who are rated must expend resources to achieve good ratings based on the Gomez rating criteria (Appendix A).

The point estimate of the CNET Certification coefficient tells us that the certification increases the price of a handheld by $7.67. However, the P-value of 0.242 indicates that the coefficient is not significantly different than zero at commonly cited levels of significance.

The Free Shipping coefficient indicates that offering free shipping increases the price of a handheld by $29.92. The Free Shipping coefficient's P-value of 0.001 indicates that the coefficient is significantly different than zero at commonly cited levels of significance. For customers, the Free Shipping coefficient's high point estimate indicates that Free Shipping is, on average, more expensive than paid shipping. Being guaranteed free shipping up front reduces the risk of being charged more than the customer expects; but customers who take this option must expect, on average, to pay more than those who take the risk of discovering high shipping charges when they are one mouse click away from submitting their order.

The specification tests are consistent with two-way random effects. First, Breusch and Pagan's Lagrange multiplier statistic leads us to reject the null hypothesis that the random effects are significant restrictions on the model, since the P-value is 0.000. Second, Hausman's chi-squared test yields a P-value of 0.628, leading us to fail to reject the null hypothesis of no fixed effects. This is the expected pattern for a model in which there are random effects.

Conclusion

Scott and Miller's (2001) application of Hotelling's linear city model yields the result that because the Internet eliminates the possibility that firms can differentiate themselves on the basis of physical location that ecommerce firms develop other dimensions on which to differentiate their products. Scott and Miller cite CNET's shopping site as providing examples of the ways in which vendors seek to differentiate their services through certification, rating, advertising, and offering various mixes of services. Scott and Miller hypothesize that, consistent with the linear city, these differentiations will be priced. This study finds that differences in the level of service of handheld vendors are priced. Vendors with higher levels of service, as measured by the Gomez ratings, charge higher prices. Vendors who differentiate their products by placing convenient and attractive advertisements charge higher prices. Vendors who reduce the overall risk to the consumer by offering free shipping are likely to more than compensate by charging higher prices. CNET's certification was not shown to increase vendor prices.

Price theory makes detailed formal predictions that may be applied in a wide variety of environments. Some price theory that applies to offline markets may be modified to shed light on online markets. This is one attempt at applying traditional price theory to online markets. One direction for future research is investigating whether a larger number of vendors of a single product causes the price to be lower due to competition. In addition, future research could

compare the differentiation and pricing of products sold online to products sold online. Further, future research could investigate whether sellers' pricing and differentiation online matches their pricing and differentiation offline.

Table 1
Descriptive Statistics on Price

Handheld Model	Vendors	Mean Price	Std. Dev. Price	Minimum Price	Maximum Price
Cassiopeia E125	30	410.48	51.83	349.95	539.99
Compaq Ipaq H3650	30	471.98	38.93	414.00	549.00
Palm M500	35	362.10	36.79	299.00	402.95
Palm M505	39	409.77	34.35	365.90	449.99
PalmVx	40	249.20	42.76	202.00	299.99
Sony CLIE PEG-N710C	24	465.74	31.17	422.95	500.00

Table 2
Descriptive Statistics on Independent Variables

Handheld Model	Gomez Rating	Gomez Rated?	Advertise	Free Shipping	CNET Certified
Cassiopeia E125	2.68	0.83	0.03	0.10	0.73
Compaq Ipaq H3650	2.65	0.67	0.07	0.10	0.77
Palm M500	2.70	0.77	0.09	0.11	0.74
Palm M505	2.63	0.77	0.10	0.10	0.72
PalmVx	2.70	0.78	0.10	0.10	0.70
Sony CLIE PEG-N710C	2.72	0.75	0.13	0.13	0.83

Table 3
Two-Way Random Effects Estimates
(Dependent Variable is Price)

Variable	Coefficient	Prob Value
Constant	373.32	0.000
Advertising	23.11	0.017
Gomez Rating	5.22	0.031
CNET Certification	7.67	0.242
Free Shipping	29.91	0.001
Lagrange Mult Test	2390.41	0.000
Hausman Chi-Squared	2.59	0.628

Appendix A
Gomez Rating Service Criteria

Baseline criteria:

  Offers reasonable access to customer support (phone or email)
  Uses a shopping cart technology and totals an order
  Ensures site failure is less than 5 percent
  Uses secure server transaction
  Accepts multiple credit cards
  Offers a published return policy
  Offers a published FAQ/Help policy

Supplemental criteria:

  Merchant responds to email within 24 hours
  Merchant provides product tech support
  Store offers minimum of 30-day guarantee
  Merchant states that it will not sell customer data
  Site performance exceeds industry standard
  Site offers gift certificates
  Site offers gift-wrapping

Gómez Certification is a review of site "shopability" and our seal confirms that the merchant has a reasonable Internet store. The program is designed to validate online merchants and build consumer confidence in e-commerce. Although criteria vary slightly by industry, particular criteria might include a review of customer service accessibility, secure server transaction system, and a clear statement of privacy and return policies.

The Merchant Certification levels are:

A merchant with a <u>Three Star review</u> has met all of the baseline certification criteria and at least four of the supplemental certification criteria.

A merchant with a <u>Two Star review</u> has met all of the baseline certification criteria and fewer than four of the supplemental certification criteria.

A merchant with a <u>One Star review</u> has not met the minimum standards for Merchant Certification.

"Gomez Certified" merchants receiving two or three stars can display the program logo on their web site. Consumers can click the program logo to view the specific Certification criteria reviewed by Gomez staff.

Appendix B
CNET Certification Guidelines

CNET Certified Stores must meet the following requirements:
Supply CNET with up-to-date shipping and handling, prices, and stock information.
Provide a complete customer service policy on the store Web site. The policy must be clear, and easy to find. The customer service policy should include information on, but not limited to, the following areas:

- Shipping and Returns
- Contact information
- When credit cards are charged

Honor prices displayed on store Web site, without any hassle or excuses.
Price links direct user to product "buy" page.

Provide a fully e-commerce enabled site. Resellers must be able to accept, process, and complete online orders entirely online. Requiring follow-up phone calls from either the user or the reseller is not permitted unless there is a problem with the order.

Promise to conduct all transactions in a secure environment, using a secure commerce server and encryption technology.

Process orders promptly and send an email confirmation and order summary within (1) business day of the initial order. If item is back-ordered, up-to-date stock information must be provided.

Deliver merchandise in professional packaging

- Undamaged boxes
- Adequate padding
- Packing slips indicating contents of package

Respond to all customer service emails and phone calls within two (2) business days.

CNET's promise. If you buy from a CNET Certified Store through the CNET Shopper site and the CNET Certified Store charges your credit card for unauthorized purchases, CNET will reimburse you for any amount of such unauthorized charges for which your credit card company holds you liable up to a total of $50. You must follow your credit card company's rules and regulations in regard to reporting unauthorized charges.
If you encounter any problems with a CNET Certified Store, please contact us.

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