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EERI Research Paper Series No 07/2009

ISSN: 2031-4892

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Price Dispersion in the Online Auction Markets

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November 12, 2008

Abstract

Along the standard measures of price dispersion, this paper proposes a new method, the residual variance model, to examine the levels of price and price variation within and across 10 kinds of physically identical products on eBay UK. The results find that the price levels and price dispersions on eBay are lower than the ones reported in the prior literature regarding other online markets, but the 'law of one price' has not prevailed in any sample category. It further suggests an important interaction between the extent of price dispersion and the heterogeneities of consumers and sellers.

1 INTRODUCTION

Online auction markets, such as eBay, have many characteristics of perfect competitive markets. On eBay, it is likely to have many sellers in a product category; information is instantaneous and bidders are free to compare the offerings of sellers worldwide simultaneously. With hardly seller differentiation, one may expect fierce price competition for physically identical goods. However, Luo (2008) examines 860 transaction records of four sample products (Canon 350D digital SLR cameras, Mamas & Papas 2-in-1 prams, Sony Ericsson K300*i* mobile phones and Converse All Star shoes) on eBay UK during the period 21st January to 20th February, 2007. The standard errors of regressions that show the levels of price variation after having allowed for possible influential factors have varied significantly between 5% and 20% across the samples after allowing for the systematic factors. Figure 1 plots the percent ranges of these four samples (i.e. the difference between highest and lowest auction prices divided by the lowest price) at the date level. It shows that the respective ranges for Canon, Mamas & Papas, Sony Ericsson and Converse are 28%, 44%, 98% and 241%. Whereas the ranges for Canon and Mamas & Papas fluctuate modestly, they vary considerably in Sony Ericsson and Converse. Thus, this paper empirically investigates the levels of price and price dispersion among a large variety of physically identical products in the online auction markets.

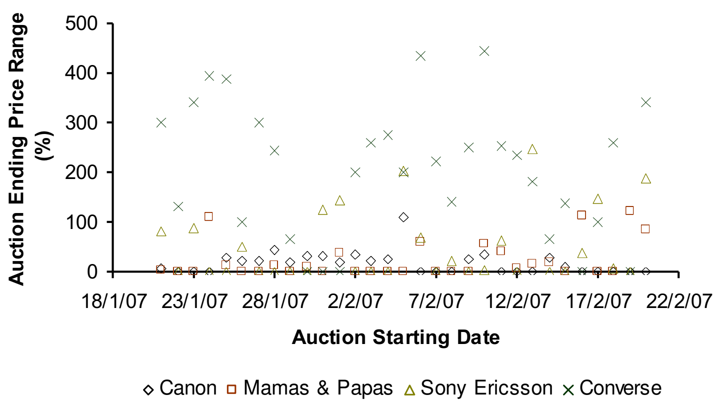

Figure 1: Price Ranges for Four Product Categories on EBay

Various measures of price dispersion have been adopted in the literature. The absolute measures of dispersion include variance, standard deviation of the distribution, range between the highest and the lowest prices, gap between two lowest prices and value of price information (i.e. difference between the average and lowest prices). Meanwhile, two relative indicators are coefficient of variation (i.e. the ratio of the standard deviation to the mean price) and percentage range. Further, Baye et al. (2004) propose another relative measure of dispersion - the percent gap that is the difference between the lowest two prices relative to the lowest price. If prices approach marginal costs and firms are efficient, the Bertrand outcome prevails and the gap measure approaches zero. Inevitably, different measures may generate different results.

The correct dispersion measure depends on the price distribution and the question of interest. Although the price theory in literature provides no axiomatic basis for these standard measures, it is to understand where price differences come from. Thus, the paper uses the most popular ones in literature: the coefficient of variation, the percent range and the percent gap. Meanwhile, standard deviation of the normalised price is included as a double check, since both range and gap depend upon the extremes of price distribution that can be sensitive to outliers in the sample data. Further, I propose the residual variance model as a new method that measures the variance of proportional deviations from the normalised auction prices. To the best of my knowledge, there is no explicit theoretical basis for this method. However, it is a natural dispersion measure raised from the price regression, since it is comparable across different products as an average percentage deviation correcting the product and the auction characteristics. In the linear case, it corresponds the coefficient of variation roughly.

Although prior studies suggest many reasons for the low online price dispersions, some studies have found contradicting evidence. Among others, Clay et al. (2001) investigate the price dispersion in the online book industry by studying 399 books in 5 categories from 32 online bookstores over 25 weeks. They find that widely advertised books have the lowest average price and the highest price dispersion and explain that retailers discount prices of some popular products to attract consumers into buying bundles of products. Lee and Gosain (2002) examine the price distributions for music CDs among 9 online retailers and 5 nationwide retailers between February 1999 and January 2000. They show that the average percent price difference is not smaller online and the dispersion depends on whether the product is a popular or a niche product. In a comparison study by Scholten and Smith (2002), they empirically show that price dispersions in both retail and online markets were at least as large in 2000 as they were in 1976.

Besides, a few studies present some interesting relations between price and some measurable characteristics. Brown and Goolsbee (2002) find lower price levels of life insurance online and demonstrate that price dispersion initially increases as the number of informed consumers increases, but the dispersion falls as it increases further. Baye et al. (2004) find that an increase in the number of sellers affects the degree of price dispersion depending on if and how this change affects the consumer demand. Gatti and Kattuman (2003) reveal that relative price dispersion falls as the price level rises, so the cheap goods have relatively greater price dispersion than the expensive goods.

Further, most of studies on online price dispersion use posted prices or click-through rates published on the price comparison sites and explain price variations at the aggregate level or on a narrow set of markets (typically US books, CDs or computing), as shown in Appendix A. In contrast, Ghose and Yao (2006) use the actual transaction prices of 4 product categories from online and conventional markets of government buyers. They find that online price dispersion is substantially smaller than that reported in the prior literature and the 'law of one price' prevails in some markets. Anderson et al. (2007) test the price variations for Palm Pilot Vx on eBay and interpret that price dispersion on eBay is low relative to the degree of heterogeneity in seller strategies, because of the market competitiveness for such products. However, the results may be biased by the product and/or market characteristics, because 1) the analysis involves only one product; and 2) eBay has developed considerably compared with its early stage in 2001 when the data was originally collected. Thus, this paper proposes the residual variance method as a new dispersion measure. Together with the standard measures, it explores the extent to which price dispersion varies within and across 10 types of physically identical products in the online auction markets.

The remainder of this paper is organised as follows. Section 2 explains the measures of the price dispersion and methodology used to collect the data, and it provides a description of the data. Regression results for the levels of price and price variation are presented in Section 3 and final conclusions are continued in Section 4.

2 METHODOLOGY AND DATA

2.1 Measures of Price Dispersion

Price dispersion can be interpreted intuitively as the difference between the product price and the expected value of product. The standard methods assume that the expected value of product is a constant equal to the mean. They measure the distribution of prices in a time period, but the observed dispersion may result from the products being different in many ways that are not reflected. Then, price dispersion is explained at the second stage of the regression by various factors. Another method assumes the expected value differ with the product and the auction characteristics, and this variation will increase measured dispersion. Therefore, residual variance model allows the factors to explain the variance at the first stage. It reduces the heterogeneities of consumers and sellers in the price-level regression and explores if certain factors have linear or non-linear effects on the measured dispersion at the second stage. It explains as much price variation as possible using observed product and auction characteristics and then analyses the remaining price variation that is left unexplained.

Suppose we observe a set of prices for a product, P_i, where $i = 1...N$. There is an issue of measuring how dispersed the observations are. In the theoretical models, dispersion is usually treated in a very simple way. For instance, Salop and Stiglitz (1982) consider a market with identical buyers who live for two periods and each buyer has one purchase in each period. Also, some models assume homogenous sellers (e.g. Wilde and Schwartz, 1979); some assume homogeneous buyers who buy the lowest priced goods (e.g. Rosenthal, 1980) and some assume homogeneous buyers and sellers (e.g. Diamond, 1971). However, data does not usually come in this form but has a complicated distribution of prices. As discussed in Section 1, there are a large variety of possible measures of price dispersion, but they all have some limitations. For instance, when the mean value is near zero, the coefficient of variation is sensitive to small changes in the mean. The percent range shows the difference between the highest and the lowest prices and the percent gap indicates the difference between the lowest two prices relative to the lowest price. However, both measures can be sensitive to the extreme observations. The most common absolute measure of dispersion is the variance or standard deviation that is the positive square root of variance. The variance of P_i, denoted by $Var(P_i)$, is defined as,

$$Var(P_i) = E([P_i - E(P_i)]^2) \tag{2.1}$$

Thus, $Var(P_i)$ is the mean squared deviation of P_i from its unconditional expected value $E(P_i)$. If the distribution of prices is normal, this is a good measure. Any other measures of dispersion are functions of the variance. Since the observed price data may be skewed, it is common to take logarithm of prices, $log(P_i)$, and substitute $log(P_i)$ into the measure. In this sample data, one may expect that the price distribution in each category is skewed bumping up against the minimum bids as a lower bound. Therefore, the normality of the data needs to be tested. However, there may be heterogeneity in other characteristics that influence the prices, e.g. the nature of the auctions. In those circumstances, the conditional variance may be a better measure. The conditional variance of a random variable P_i given the value of X_i is

$$Var(P_i \mid X_i) = E([P_i - E(P_i \mid X_i)]^2 \mid X_i) \tag{2.2}$$

where X_i is a vector of observed characteristics. Under normality, the conditional expectation of P_i can be written as,

$$E(P_i \mid X_i) = \beta' X_i \tag{2.3}$$

where $P_i = \beta' X_i + u_i$. β is $k \times 1$ vector. Therefore, β can be estimated by least squares and the standard error of regression, s, is defined as,

$$s = \sqrt{\sum \hat{u}_i^2 / (n-k)} \tag{2.4}$$

where $\sum \hat{u}_i^2$ is the sum of estimated squared residuals, k denotes the number of regression coefficients estimated and n is the number of observations. This is an estimate of the square root of the error variance and gives an idea of the average size of the errors. However, there may also be systematic factors influencing the expected price dispersion and this can be investigated by considering the regression,

$$\hat{u}_i^2 = \gamma' Z_i + v_i \tag{2.5}$$

The possible candidates for Z_i are X_i, the squares and cross products of these variables. The method captures some non-linear effects that are not shown in standard measures. For instance, prices may be less dispersed in the short or long durations but more dispersed when the auction durations are in between. Also, the distribution of prices is more dispersed with low or high minimum bids but less dispersed when minimum bids are in between. These relations can be tested later in the paper. Notice that Equation (2.5) is the standard White's (1980) heteroscedasticity test, but its interpretation is different. It asks that given certain characteristics of an auction how large is the expected price dispersion for a product likely to be.

2.2 Data Collection

The data is collected manually via 'Completed Listings Search' on eBay UK. It is then transferred into Microsoft Excel and EViews 5 for the regression analyses. Throughout data collection, I have attempted to capture all the relevant information of auctions and preserve the originality of the data. However, a few details need to be mentioned: 1) 2.5% of total auctions without any bid are omitted from the data; and 2) in total of 1606 transaction records, 31 records are omitted since they are located outside the UK; 21 records are rejected because of the private listings with the hidden number of bidders and bidders' identities, and 12 records are removed because of the hidden reserve prices. Accordingly, the sample consists of 1538 observations of 10 kinds of physically identical products in 4 categories between 1st and 31st August 2007. All chosen products are new and have no size or colour difference. Limiting the data collection to a 1-month span reduces the likelihood of potential systematic variations that may occur over time. Also, the chosen categories have different retail values. Four products have the retail prices below £100 and the other six are above £100. Specifically, the products are:

- **HEALTH AND BEAUTY**: Oral B Triumph 9900 Electric Toothbrush, GHD IV Styler and Elizabeth Arden 8 Hour Cream (50ml);
- **STAMPS**: 100 UK First Class Stamps and 100 UK Second Class Stamps;
- **CONSUMER ELECTRONICS**: Thomson Sky High Definition 300GB Box, Apple iPhone and TomTom Go 910 Satellite Navigation;
- **VIDEO GAMES**: Harry Potter: The Order of Phoenix PlayStation 2 Game and PlayStation 3 Game Console.

Table 1 overleaf presents a preliminary summary statistics of the auction prices. The mean minimum bids vary between 23% and 75% of the corresponding retail prices across samples, and 6 out of 10 products are less than half of their retail prices. As discussed in Luo (2008), sellers tend to set low minimum bids. The differences between the lowest and the highest winning bids exhibit large swings across samples. The mean winning bids of

Table 1: Summary Statistics of the Sample Data

	Oral B	GHD	8 Hr Crm	1st Cls Stp	2nd Cls Stp	Sky Box	iPhone	TomTom	HP	PS 3
No. of Observed Auctions	103	267	86	122	148	361	84	147	66	154
RRP (£)	139.99	119	19	34	24	399	299[a]	299.99	29.99	399.99
No. of Unique Sellers	12	45	41	59	60	19	49	37	43	129
Mean No. of Unique Bidders	2	2	2	4	4	1	6	2	4	6
Min Minimum Bid (£)	0.990	0.010	0.990	0.010	0.010	0.990	0.010	0.100	0.010	0.010
Max Minimum Bid (£)	83.990	105.000	13.990	31.500	19.000	189.950	550.000	274.990	26.990	400.000
Mean Minimum Bid (£)	62.855	89.683	7.734	8.479	5.453	167.763	216.396	193.177	7.972	155.598
Mean Minimum Bid/RRP (%)	44.900	75.364	40.705	24.938	22.721	42.046	72.373	64.394	26.582	38.900
Min Winning Bid (£)	56.010	62.250	3.200	12.510	8.270	147.000	305.000	160.000	10.500	205.000
Max Winning Bid (£)	83.990	105.000	13.990	33.000	24.010	189.995	701.000	274.990	28.890	400.000
Mean Winning Bid (£)	68.441	96.079	9.896	22.201	13.630	172.218	435.017	221.283	19.402	322.619
Std Dev of Winning Bid	5.540	7.941	2.174	5.069	2.696	3.693	62.076	22.427	3.415	33.514
(Mean Winning Bid-RRP)/RRP (%)	-51.110	-19.261	-48.058	-34.703	-43.208	-56.838	45.491	-26.237	-35.305	-19.343
Normalised Price (Mean/RRP)	0.489	0.807	0.521	0.653	0.693	0.432	1.455	0.738	0.647	0.807
Mean BIN Price (£)	70.703	98.561	10.584	23.868	13.552	172.520	443.965	222.666	21.915	347.705
Auctions Ended with BIN (%)	57.282	83.895	53.488	23.771	24.324	94.737	38.095	80.272	19.697	25.974
Prime-Time-Ending Auctions (%)	37.864	50.187	50.000	50.820	52.703	36.011	60.714	46.939	72.727	48.052
Weekend-Ending Auctions (%)	41.748	17.978	34.884	27.869	20.946	19.668	21.429	14.286	16.667	20.779
Multi-Channel Sellers (%)	85.437	79.775	9.302	-	-	94.737	17.857	63.265	30.303	9.091

[a] Apple iPhone launched in the US in June 2007, with RRP \$599/£299. On 18th September (after this data collection), Apple iPhone has announced that it would be launched in the UK in the 9th November 2007 at RRP GBP299 with an 18-month mobile contract with O2 at £35, £45 or £55 per month.

all the samples are lower than their corresponding retail prices except iPhone, and the average normlised price is about 0.72. However, the prices still show some variations. For instance, iPhone was launched in the US in June 2007 (two months before the data was collected), but it was not officially released in the UK till November 2007. EBay was almost the only source for UK buyers. Although buyers might notice US retail prices, the normalised price of iPhone stayed high at 1.46. The convenience for looking for a new or specific product may increase the willingness-to-pay of a buyer (Shankar et al., 1999).

Table 2: Summary Description of the Variables

Variable	Description
MINBID	The minimum bid of the auction
UB	The number of the unique bidders throughout the auction
DURATION	The length of the auction, namely 1, 3, 5, 7 or 10 days
POS	The number of users who left a positive rating for the seller
NEG	The number of users who left a negative rating for the seller
SELLERFB	The total number of feedback ratings of a seller
BUYERFB	The total number of feedback ratings of a buyer
SHIPPING	The shipping cost and any handling fee stated in auction
Auction Dummy	Description
SETBIN	1 if the auction has a buy-price option, 0 otherwise
PRIMETIME	1 if the auction ends between 4pm and 10pm, 0 otherwise
WEEKEND	1 if the auction ends on Saturday or Sunday, 0 otherwise
GALLERY	1 if the auction title includes a picture, 0 otherwise
PICTURE	1 if it lists 1 or more pictures of the product, 0 otherwise
MULTI	1 if the seller is a multi-channel seller, 0 otherwise
Product Characteristic	Description
AGE	1 if the product is launched within 1 year till Aug. 2007, 0 otherwise
VALUE	1 if the product's retail value is GBP100 or above, 0 otherwise
EXPERTISE	1 if the product needs expertise during purchase, 0 otherwise
DAILY	1 if the product is a daily/necessary product, 0 otherwise
LIFECYCLE	1 if the product will be replaced in 6 months, 0 otherwise

In addition, standard deviations of the winning bids fluctuate widely between 2.17 and 62.08. Despite some minor variations, the standard deviation increases as the mean winning bid increases. Also, apart from marginal difference in Second Class Stamps, the mean Buy-It-Now prices for all other products are higher than their corresponding mean winning bids. The data shows that more than half of the auctions are ended via buy-price options, but the choices vary greatly across categories. The auctions of Stamps and Video Games are ended mainly via bidding, whereas more than half of the auctions in Health and Beauty sector are ended via buy prices. Regarding the ending time, about half of the auctions end during the prime time, while only 24% of the auctions end at weekends. Thus, the possible indicators for the analyses are stated in Table 2 and the names of the variables are given in capital letters. These variables are the same ones used in Luo (2008), apart from that this paper adds in product characteristic dummies but excludes 'LOCATION', 'REFURBISHED' and 'ENDBIN'. Notice that all the samples in this paper are located in the UK and brand new.

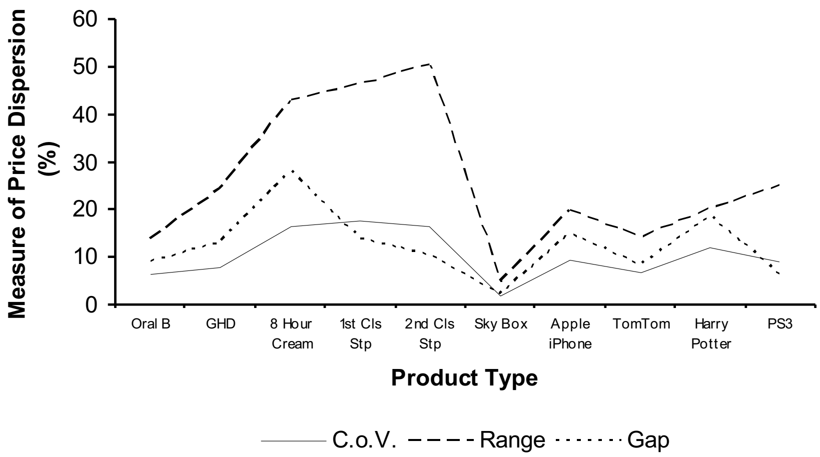

Figure 2: Price Dispersion for All the Products under Three Standard Measures

Figure 2 compares the degrees of price dispersion for all the products at the date level. It uses three standard measures: coefficient of variation, percent range and percent gap. Despite some differences, the measures remain consistent for most of the samples.

Table 3 overleaf ranks the measured dispersions across samples under the standard measures. Along Table 1, it indicates various degrees of price dispersion appear before controlling the factors of the product and the auction. The average coefficient of variation, percent range and percent gap display 10%, 26% and 12% respectively. These are lower than the results reported in the prior studies in Appendix A. Despite some minor variations, Tables 1 and 3 reveal that the coefficient of variation and range increase as the mean winning bid and its standard deviation decrease. It appears to fit into the pattern of Stigler's (1961) conjecture. That is, the expected savings of a consumer who purchases an expensive product would be large, resulting in a greater number of searches. Price volatility may be relatively lower for high-valued products than low-valued products.

Table 3: Summary of the Levels of Price Dispersion at the Date Level

Product	No. of Obs	C.o.V. (%)	C.o.V. Rank	Range (%)	Range Rank	Gap (%)	Gap Rank
HEALTH AND BEAUTY							
Oral B	31	6.413	2	13.794	2	8.861	4
GHD IV	31	7.690	4	24.116	6	13.068	6
8 Hour Cream	31	16.306	9	42.894	8	28.006	10
STAMPS							
1st Cls Standard Stamp	31	17.452	10	46.242	9	13.842	7
2nd Cls Standard Stamp	31	16.277	8	50.190	10	10.310	5
CONSUMER ELECTRONICS							
Sky Box	31	1.777	1	5.026	1	2.097	1
Apple iPhone	31	9.413	6	19.687	4	15.052	8
TomTom	31	6.532	3	14.229	3	8.265	3
VIDEO GAMES							
Harry Potter	29	11.952	7	20.048	5	18.683	9
PlayStation 3	31	8.952	5	25.048	7	6.329	2
AVERAGE	30.8	10.276	-	26.127	-	12.451	-

In contrast, search costs theory predicts that price variations for homogeneous goods will be alleviated and may eventually disappear in the online markets because of the reduced search costs for both price and product specifics. Especially, price variation is expected to be low for products with low search costs, typically frequent purchases. One may expect that UK buyers are very likely to be informed about the prices of UK Standard Stamps that are sold throughout UK post offices. On eBay the number of auctions for each type of standard UK stamps is relatively low, so bidders are able to browse most of the auctions. However, none of the measures has fitted neatly into the theoretical prediction. Table 3 shows that the Stamp category has the highest ranking for the dispersions of prices in general. Contrary to the retail prices of First and Second Class Standard Stamps at £34 and £24, the maximum winning bids in the data are £33 and £24.01 respectively as shown in Table 1. The total prices including postage are higher than their retail prices. Meanwhile, the auction prices for Sky Box display the least price variation under each measure. PlayStation 3 shows inconsistent results across measures: the coefficient of variation and the price range are ranked at 4 and 7 respectively, while its gap is ranked at 2. The detailed graph of the price dispersion of each product is plotted in Appendix B.

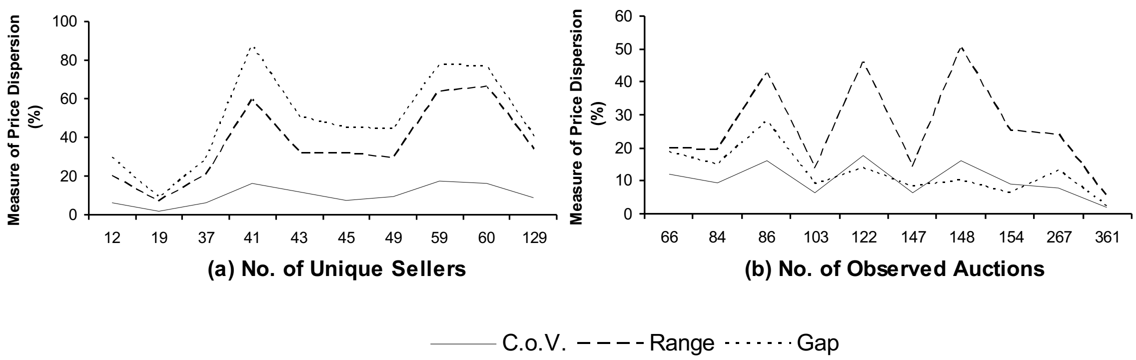

Figure 3: Price Dispersion against the No. of Unique Sellers and Observed Auctions

In addition, some figures are graphed to observe the impacts of certain systematic factors. In Figure 3, three standard measures are roughly consistent. Figure 3(a) plots three dispersion measures against the number of unique sellers at the date level for all the samples. The level of price variation increases significantly when the number of unique sellers increases from 19 to 41 but drops after. However, it fails to reveal a clear trend as a whole. Different from other retail and online purchases, consumer demand and auction prices on eBay are not influenced by the number of sellers on a particular day but all similar auctions throughout or even before the auction. An increase in the number of sellers is associated with either an increase or a decrease in price variations depending on how it affects consumer demand. The complexity cannot be captured further at this stage of the analysis. Further, Figure 3(b) exhibits a possible inverse relation between gap measure and the number of the auctions on eBay.

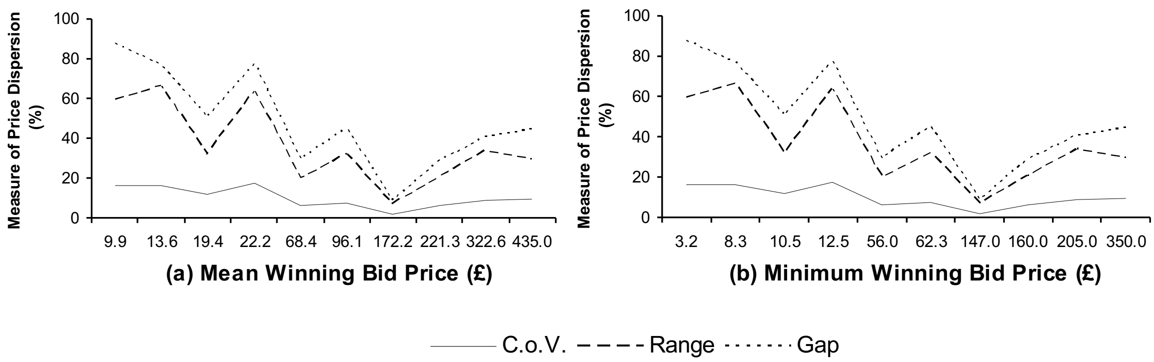

Figure 4: Price Dispersion against Mean and Minimum Winning Bids

Figure 4 compares the impacts of mean and minimum winning bids on the price dispersions. It suggests that all three measures decline initially as the minimum and mean winning bids increase while they rise after. Consistent with Gatti and Kattuman (2003), it indicates a possible negative relation between auction ending price and price variation. Indeed, Section 2 has described many important phenomena exhibited in the sample. Section 3 will conduct a series of econometric analyses to compare the measured dispersions of 10 products under both standard and residual variance methods.

3 Empirical Analyses and Results

3.1 Price Level

To estimate price dispersion, the section begins the regressions of normalised prices for both cross and within products. In a homogeneous good market, price variations mainly come from heterogeneities of consumers and sellers, such as experience of buyers and qualities of sellers in terms of their feedback, auction formats and timing factors. Thus, the pooled price levels can be estimated by the auction characteristics either with product-characteristic dummies or product-category dummies. The characteristic dummies may show the effects of systematic factors among products, however the category dummies will capture the effects of unobserved characteristics of the products. Let us start the regression with product-characteristic dummies.

3.1.1 Price Regressions with Product-Characteristic Dummies

Table 4: Product Characteristics Across Samples

Product	AGE (New)	VALUE (Expensive)	EXPERTISE	DAILY	LIFECYCLE (Short)
HEALTH AND BEAUTY					
Oral B	✓	✓		✓	✓
GHD IV		✓		✓	✓
8 Hour Cream				✓	
STAMPS					
1st Cls Standard Stamp				✓	
2nd Cls Standard Stamp				✓	
CONSUMER ELECTRONICS					
Sky Box		✓	✓		
Apple iPhone	✓	✓			✓
TomTom		✓	✓		✓
VIDEO GAMES					
Harry Potter	✓				
PlayStation 3	✓	✓	✓		

Having allowed for the characteristic dummies identified in Table 4, the regression results are displayed in Table 5 overleaf. The R-squared value suggests that 71% of the variation in the normalised prices can be explained by the observed product and auction characteristics. However, R-squared is a relative measure and it is not informative on the absolute magnitude of the variation left unexplained. Potentially, 29% of the unexplained variation in the model may still be sizeable.

Table 5: OLS Regression Results with Product-Characteristic Dummies

FULL SAMPLE ANALYSIS - 1538 OBSERVATIONS Dependent Variable: ln(PL)			
Independent Variable	Coefficient	Std Error	P-Value
ln(MINBID)	0.010379	0.004518	0.0217**
ln(UB)	0.034135	0.013717	0.0129**
ln(DURATION)	0.027352	0.008961	0.0023***
ln(POS)	0.020610	0.004044	0.0000***
ln(NEG+1)	0.009260	0.005435	0.0886*
ln(BUYERFB)	-0.004277	0.002617	0.1024
ln(SHIPPING)	-0.048923	0.002448	0.0000***
WEEKEND	-0.041736	0.011621	0.0003***
PRIMETIME	0.022083	0.009644	0.0222**
GALLERY	0.041107	0.015902	0.0098***
PICTURE	0.070479	0.035716	0.0486**
SETBIN	0.053276	0.022863	0.0199**
MULTI	-0.249940	0.017928	0.0000***
AGE	0.318440	0.016683	0.0000***
VALUE	0.201465	0.020127	0.0000***
EXPERTISE	-0.825966	0.025873	0.0000***
DAILY	-0.756063	0.026809	0.0000***
LIFECYCLE	-0.232550	0.020273	0.0000***
CONSTANT	-0.016811	0.056698	0.7669
R-Squared	0.70777	Mean Dep Var	-0.46408
Adjusted R-Squared	0.70430	SD Dependent Var	0.33867
SE of Regression	0.18416	Sum Squared Resid	51.51659
Akaike Info Criterion	-0.53375	Log Likelihood	429.4536

Note: Standard errors are listed in parenthesis;
* represents 90% significance, ** represents 95% significance, *** represents 99% significance

Most coefficient estimates provide statistically significant results with the expected signs in accordance with Luo (2008), apart from that the coefficient estimate of 'negative feedback' shows the positive sign and the 'buyer's feedback' has an insignificant result. Regarding the effect of negative feedback, the existence of business sellers in the market may play an important role. Feedback cannot be interpreted in the same way once some sellers can differentiate themselves by the established reputations. The negative feedback of these dominant sellers may not show a negative and statistically significant impact, particularly in the low-valued homogenous product market. Further, with respect to the product-characteristics, newly-launched (AGE) and high-retail-value (VALUE) characteristics have positive impacts on the normalised price, whereas a daily-use, expertise-necessary, or soon-to-be-replaced (LIFECYCLE) product tends to have a lower normalised price. In general, the pooled price levels can be explained reasonably by the observed characteristics of product and auction.

3.1.2 Price Regressions with Product-Category Dummies

Table 6 displays the results for the OLS regressions with product-category dummies. Contrary to Table 5, the R-squared value has increased to 88% accompanied with a lower Akaike Info Criterion (AIC) value. It indicates that the product intercepts provide a better fitting model than the characteristic intercepts.

Table 6: OLS Regression Results with Product-Category Dummies

FULL SAMPLE ANALYSIS - 1538 OBSERVATIONS Dependent Variable: ln(PL)			
Independent Variable	Coefficient	Std Error	P-Value
ln(MINBID)	0.011517	0.002910	0.0001***
ln(UB)	0.037931	0.008884	0.0000***
ln(DURATION)	0.002283	0.006006	0.7039
ln(POS)	0.003092	0.002628	0.2395
ln(NEG+1)	-0.013986	0.003537	0.0001***
ln(BUYERFB)	-0.003804	0.001710	0.0262**
ln(SHIPPING)	-0.017001	0.001721	0.0000***
WEEKEND	-0.011847	0.007488	0.1138
PRIMETIME	0.012594	0.006210	0.0427**
GALLERY	0.059676	0.010679	0.0000***
PICTURE	-0.014265	0.023473	0.5435
SETBIN	0.113641	0.014757	0.0000***
MULTI	-0.005375	0.013242	0.6849
ORALB	-0.534446	0.017128	0.0000***
GHD	-0.112332	0.016229	0.0000***
8HR	-0.462704	0.018835	0.0000***
1ST	-0.228631	0.018676	0.0000***
2ND	-0.339404	0.018352	0.0000***
SKY	-0.658801	0.015212	0.0000***
IPHONE	0.565290	0.016142	0.0000***
TOM	-0.102481	0.015628	0.0000***
HP	-0.208915	0.019665	0.0000***
CONSTANT	-0.341521	0.036560	0.0000***
R-Squared	0.880287	Mean Dep Var	-0.464080
Adjusted R-Squared	0.878549	SD Dependent Var	0.338666
SE of Regression	0.118025	Sum Squared Resid	21.10366
Akaike Info Criterion	-1.421006	Log Likelihood	1115.753

Note: Standard errors are listed in parenthesis;
* represents 90% significance, ** represents 95% significance, *** represents 99% significance

The general results of two regressions are consistent. All the estimates exhibit the same signs under both regressions, apart from that the effect of negative feedback is negative and highly significant in Table 6. All of the product dummies present highly significant and negative impacts except iPhone. It is consistent with Table 1 that the normalised prices of all the products are lower than their corresponding retail prices except iPhone. Compared with the regression in Table 5, the effects of DURATION, POS, WEEKEND, PICTURE and MULTI provide insignificant results in Table 6. It suggests that product intercepts provide more explanations for the regression. Since these effects may vary depending on how these factors affect the demand of the consumer niches, it is necessary to run the regressions within products.

3.1.3 Price Regressions within Products

The normalised price of product i can be explored within each category as follows:

$$\begin{aligned} \ln(\text{PL})_i &= \beta_0 + \beta_1 \ln(\text{MINBID}) + \beta_2 \ln(\text{UB}) + \beta_3 \ln(\text{DURATION}) + \beta_4 \ln(\text{POS}) \\ &\quad + \beta_5 \ln(\text{NEG+1}) + \beta_6 \ln(\text{BUYERFB}) + \beta_7 \ln(\text{SHIPPING}) + \beta_8 \text{WEEKEND} \\ &\quad + \beta_9 \text{PRIMETIME} + \beta_{10} \text{GALLERY} + \beta_{11} \text{PICTURE} + \beta_{12} \text{SETBIN} \\ &\quad + \beta_{13} \text{MULTI} + u_i \end{aligned} \tag{3.1}$$

The regression results are presented in Appendix C. R-squared values indicate that between 20% and 78% of the variance in the normalised prices can be explained by the respective independent variables across regressions. Thus, the explanatory ability of each regression varies with the product. Overall, the results are consistent with pooled regressions in Sections 3.1.1 and 3.1.2. The interesting results are highlighted here. Only three out of ten MINBID estimates are positive and statistically significant. As mentioned in Luo (2008), the effect of minimum bid is expected to be positive, but the effect may be opposite if the auction with a low starting price attracts the number of bidders and increases bidding competition. Seven out of ten coefficients for UB have the positive sign, and three of them are statistically significant. The effect can be opposite if a large proportion of sellers set high buy prices. For instance, about 84% of GHD are sold through buy-price options and the average buy price is higher than its average winning bid. Thus, the number of unique bidders shows a negative and significant impact in GHD. Further, seven WEEKEND coefficients are negative, but it is only statistically significant in GHD. Also, only three out of eight positive coefficients for PRIMETIME are statistically significant. Consistent with Luo's (2008) findings, the ambiguous timing effects reflect that online auctions are less timing-restrictive, particularly when the proportional auctions with buy prices are high.

Further, six out of eight estimates for MULTI are negative but not all statistically significant. The effects vary with the proportional multi-channel sellers, their purposes on eBay and the auction methods. If a multi-channel seller intends to clear a large quantities of surplus inventories, the seller is likely to set relatively low minimum bids or buy prices, as shown in TomTom. Expectedly, its coefficient for MULTI shows a negative and significant effect at 1% significance level. However, the result can vary if these multi-channel sellers attempt to expand the market and capture the buyers with different values.

Table 7: Price Level Model Selection with AIC

MODEL	K	AIC	$\triangle_i$	w_i
Price Regression (Characteristics)	19	-0.534	20.105	0.00004
Price Regression (Category Dummies)	23	-1.421	19.218	0.00007
Price Regressions within Products	134	-20.639	0	0.99989

Table 7 compares the AIC values of three price regressions. K is the number of parameters in the model and $\triangle_i$ denotes the difference in AIC values between the best fitting model and model i. w_i is known as Akaike weights for model i, where $w_i = \frac{\exp(-\triangle_i/2)}{\Sigma_{r=1}^{R} \exp(-\triangle_r/2)}$ (Turkheimer et al., 2003). The denominator is the sum of the relative likelihoods for all candidate models and R is the number of models. Given the data and these models, w_i can be interpreted as the probability that i is the best model. For instance, the regression with product intercepts is 1.75 ($0.00007/0.00004 = 1.75$) times more likely to be the best explanation for the price level than the regression with product-characteristic dummies. As suggested by Royall (1997) as a general rule-of-thumb for evaluating strength of evidence, the confidence set of candidate models include models with Akaike weights that are within 10% of the highest. This includes any candidate model with a value greater than 0.10 ($0.99989 * 10\% = 0.10$), so both pooled regressions lose information. Product-specific model provides the most plausible explanation for the price level of the sample. Further, although some coefficient estimates in product-specific regressions have not shown statistically significant results, most of the estimates in the pooled regressions are statistically significant. It is possibly because the pooled regressions pick up the cross-section effects of the systematic factors.

3.2 Price Dispersion - Standard Measures

This subsection estimates a series of regressions in which various standard measures of price dispersion are used as the dependent variables. Measured dispersions spread across the positive ranges, but some observations exhibit zero dispersion at the date level. In fact, the percentage of these observations is larger than what one would expect under a normal distribution. Of all 308 daily observations, 14 (5%) cases take the value of zero in the coefficient of variation and the range, and 51 (17%) cases are zero in the gap measure.

The dependent variables have censored distributions, i.e. they are left-censored at zero. Therefore, Tobit regression has been adopted as the estimation method.

3.2.1 Price Dispersion Regressions with Product-Characteristic Dummies

The daily price dispersion of product i can be represented as the following regression,

$$\begin{aligned} Disp_{i,m} = \; & f(\text{MINBID, UB, DURATION, SELLERFB, BUYERFB, SHIPPING,} \\ & \text{WEEKEND, PRIMETIME, GALLERY, PICTURE, MULTI, SETBIN,} \\ & \text{EXPERTISE, AGE, DAILY, LIFECYCLE)} \qquad (m = 1, 2, 3 \text{ and } 4) \end{aligned} \tag{3.2}$$

where m is the m^{th} measure of price dispersion. The results are displayed in Appendix D(a). Three standard methods of dispersion and the standard deviation of normalised prices, expressed as ratios, are used as the dependent variables. The dummy variables are equal to 0 if all the auction conditions on a given date are identical, 1 otherwise; and all other independent variables are the respective mean values on a given date. The dummy variable, VALUE, is omitted in these regressions, as PRICE is included to control the product value. In the initial modelling effort, I separated the negative feedback ratings from total ratings. However, the results are not statistically significant, possibly because the average negative feedback on a given date is very close or equal to zero. Price variation is more associated with members' total feedback ratings.

As shown in Appendix D, standard deviations of dependent variables vary significantly from 8% to 29%, while standard errors of the regressions differ from 7% to 25%. The level of price variation left unexplained remains sizeable, although it has shrunk compared with the results of prior studies shown in Appendix A. Note that the analyses use the actual transaction data compared with the posted prices in the other studies. PRICE effects are positive but not all statistically significant, so the product prices may not affect the levels of price variation. Moreover, except the regression for standard deviation, the result shows a strong positive relation between SETBIN and all the dispersion measures at 1% significance level with the average coefficient of 0.06. Hence, auctions with buy prices can boost the degree of price variation by 6% in general. Reynolds and Wooders (2004) and Hidvégi et al. (2006) explain that if some auctions include the buy prices and others involve straight auctions, then in a separating equilibrium, more risk-averse and/or impatient bidders will go for the buy prices. This may widen price distributions. Another interesting finding is that WEEKEND dummies exhibit positive and significant effects at 1% significance level in the regressions of coefficient of variation and the range, and at 10% significance level in standard deviation regression. Further, the estimates for WEEKEND and PRIMETIME suggest that weekend-ending auctions are associated with higher levels of price dispersion than the prime-time-ending auctions. These reflect that bidding behaviour of the bidders' are more diverse at weekends within each consumer group. Also, MULTI effect shows a positive but insignificant impact.

The estimates for product-characteristic dummies reveal various significant effects on the degree of price dispersion. First, all of the coefficient estimates for AGE are positive but statistically insignificant. Thus, a newly-released product is not necessarily associated with a large dispersion of prices. Second, all of the coefficients for EXPERTISE are negative and statistically significant at 10% significance level on average with the mean coefficient of -0.08. Potentially, an expertise-necessary product may reduce the degree of dispersion of prices by about 8%. Third, contrary to the coefficients on other product-characteristic dummies, the estimates for DAILY indicate a wider distribution of prices for a daily-use product, but the results are statistically insignificant in the gap and standard deviation regressions. Finally, the LIFECYCLE impacts are negative and statistically significant on average with the average coefficient of -0.07. Thus, a soon-to-be-replaced product may reduce the level of price variation by about 7%. As a result, the degree of price dispersion in a product category is affected by specific characteristics of that product and the auctions of that category.

3.2.2 Price Dispersion Regressions with Product-Category Dummies

Now, let us estimate the degree of price dispersion of product i using the product-category dummies. Thus,

$$\begin{aligned} Disp_{i,m} = \; & f(\text{MINBID, UB, DURATION, SELLERFB, BUYERFB, SHIPPING,} \\ & \text{WEEKEND, PRIMETIME, GALLERY, PICTURE, MULTI, SETBIN,} \\ & \text{ORALB, GHD, 8HR, 1ST, 2ND, SKY, IPHONE, TOM, HP}) \\ & (m = 1, 2, 3 \text{ and } 4) \end{aligned} \quad (3.3)$$

The detailed results are shown in Appendix D(b). The standard errors of the regressions differ from 7% to 24%. The AIC value of each measure in Appendix D(b) is lower than its corresponding value found in Appendix D(a). It implies that product intercepts explain price variations better than the characteristic intercepts. The duration effects are negative and statistically significant in all the regressions except the gap measure. It hints that the longer the auction duration, the lower the degree of price dispersion. The estimates for WEEKEND and SETBIN show the consistent results revealed in Appendix D(a). The WEEKEND dummies exhibit positive and significant effects at 1% significance level in the regressions of the coefficient of variation and the range, and at 5% significance level in the standard deviation regression. The coefficient estimates for SETBIN show the positive impacts on the measured dispersions except the standard deviation regression. Contrary to the model with characteristic dummies, the regressions with product dummies show that the MULTI effects are positive and statistically significant at 5% significance level in the measures of coefficient of variation and gap. Further, all the product-category dummies display highly significant effects in the standard deviation regression.

3.2.3 Price Dispersion Regressions within Products

To test for the robustness of above results, the product-specific regressions are practised and the results are generally consistent across measures (detailed results shown in Appendices E - H). The standard errors of the regressions that display the levels of price dispersion after controlling systematic factors vary significantly from 1.3% to 12% in the coefficient of variation, from 4% to 37.5% in the range, from 3.3% to 33.3% in the gap and from 0.6% to 12.9% in the standard deviation. Despite minor variations, the orders of standard errors of the regression are consistent across all the measures. Specifically, the standard errors of estimates are lowest in Sky Box, whereas they are high in Stamps, 8 Hour Cream and Harry Potter Game. These are consistent with the findings in Table 3 prior to having allowed for product and auction characteristics.

All of the expertise-necessary products, Sky Box, PlayStation 3 Console and TomTom, display relatively low degrees of price variation. The data reveals that these markets are strongly dominated by a few business sellers. It confirms the findings in the regression with characteristic intercepts that EXPERTISE has a negative and statistically significant effect on price variation. Also, low degrees of price volatility appear for all of the soon-to-be-replaced products apart from iPhone. IPhone has a relatively short product life cycle but it was very new to the market. Throughout the sample period, iPhone has not been officially launched in the UK and buyers could only find iPhone via search engines, so sellers on eBay have had temporary market power. Thus, its newly-released characteristic may partially offset some of other characteristics with negative effects on price dispersion. In addition, First and Second Class Standard Stamps exhibit the highest degrees of price variation among all the samples. Note that Daily is the only characteristic for the Stamps in the analyses. It is consistent with the findings in the regression with characteristic intercepts that DAILY is the only product-characteristic dummy that has positive and significant effect on price dispersion. The results are compatible with Stigler's (1961) conjecture explained in Section 3 and Gatti and Kattuman's (2003) finding that relative price dispersion falls as the price level rises so cheaper goods typically have relatively greater price dispersion than more expensive goods.

Apart from the regression for the gap, the coefficients for WEEKEND show positive and statistically significant impacts in 5 out of 10 categories for all other measures. The estimates for MULTI have positive and highly significant results for the categories dominated by multi-channel sellers, such as Oral B and GHD. Further, the data reveals that many multi-channel sellers set different starting or buy prices for the identical goods in different auctions. It may also lead to more dispersed price distributions.

3.3 Price Dispersion - Residual Variance Method

Now, let us examine the residual variance method, as discussed earlier in Section 2 Methodology and Data. It explains the observed variations using the residuals from product-specific regressions in Section 3.1.3. Each residual estimates the price that has been adjusted for the product and the auction factors. Using estimated squared residual as a proxy for the residual variance, the regressions are specified with the same independent variables in Equation (3.1) and their squares that allow for the non-linearities. Thus,

$$\begin{aligned} \hat{u}_i^2 = {} & \beta_0 + \beta_1 \ln(\text{MINBID}) + \beta_2 \ln(\text{MINBID})^2 + \beta_3 \ln(\text{UB}) + \beta_4 \ln(\text{UB})^2 \\ & + \beta_5 \ln(\text{DURATION}) + \beta_6 \ln(\text{DURATION})^2 + \beta_7 \ln(\text{POS}) + \beta_8 \ln(\text{POS})^2 \\ & + \beta_9 \ln(\text{NEG+1}) + \beta_{10} \ln(\text{NEG+1})^2 + \beta_{11} \ln(\text{BUYERFB}) + \beta_{12} \ln(\text{BUYERFB})^2 \\ & + \beta_{13} \ln(\text{SHIPPING}) + \beta_{14} \ln(\text{SHIPPING})^2 + \beta_{15} \text{WEEKEND} + \beta_{16} \text{PRIMETIME} \\ & + \beta_{17} \text{GALLERY} + \beta_{18} \text{PICTURE} + \beta_{19} \text{SETBIN} + \beta_{20} \text{MULTI} + v_i \end{aligned} \quad (3.4)$$

where $\hat{u}_i^2$ is the estimated squared residual from Equation (3.1). Notice that Equation (3.4) does not include cross products of the variables, otherwise it would run out of degrees of freedom. The detailed results are displayed in Appendix I. The effects of systematic factors vary across samples. A simple way of locating the optimal point that generates the highest or lowest degree of price dispersion within the range is optimisation. The significant results are analysed in Appendix K.

The coefficient estimates for MINBID and the squares in Sky Box and TomTom indicate statistically significant u-shaped effects. The minimum bid is a random variable and the price is a random variable with some dispersion. The expected dispersion is a function of the minimum bid. The low levels of minimum bid have large dispersions as do the high levels of minimum bid, whereas those in between have smaller dispersions. Statistically, the degrees of price dispersion for Sky Box and TomTom are lowest when the minimum bids are around £5.76 and £12.18 respectively. Meanwhile, the estimate for MINBID shows a positive and statistically significant linear effect at 5% significance level in GHD and the estimate for MINBID square for 8 Hour Cream has a negative and significant linear effect at 10% significance level. Thus, a small increase in the level of minimum bids does not influence the price variation in 8 Hour Cream, but its distribution of prices gets far more dispersed when their minimum bids are at really low level. Overall, the coefficients for MINBID show ambiguous effects on the price dispersion across products.

The number of unique bidders has an n-shaped and statistically significant effect in TomTom. It has the highest degree of price dispersion when the auction has about 6 unique bidders which are three times of its average number. Also, the number of unique bidders has a positive and highly significant linear effect on the residual variance in Sky Box.

Timing factors provide various effects across the samples. The highly significant and n-shaped DURATION effect in Sky Box indicates that Sky Box prices are less dispersed in the short or long durations but most dispersed when the auction durations are about 3 or 5 days. DURATION in PS 3 Console presents a negative and significant linear effect at 10% significance level. In addition, the coefficient estimates for WEEKEND shows a positive and significant linear effect at 5% significance level in GHD and a negative and significant linear at 5% significance level effect in TomTom. PRIMETIME effects are generally insignificant in most of the categories, apart from that it has a negative and significant linear effect in Second Class Stamps at 5% significance level.

The estimates for POS show the negative and significant linear effects in Sky Box and iPhone at 1% and at 5% significance levels respectively. Thus, the higher the positive feedback ratings, the more consistent bidding results sellers possibly receive. The estimate for squared POS in GHD has a positive and statistically significant effect. It implies that although an increase in positive feedback does not necessarily increase the degree of price dispersion, but a considerably large increase in the number of positive feedback ratings will accelerate the price dispersion. Meanwhile, POS shows a statistically significant n-shaped effect in 8 Hour Cream and the dispersion is highest when the number of the seller's positive ratings is about 66.

Similarly, the coefficient estimate for NEG in Sky Box suggests a statistically significant n-shaped effect in Sky Box. The result further shows that the negative ratings of 2 causes highest level of price dispersion. The coefficient estimates for NEG show the negative and significant linear effects in GHD and TomTom, whereas it has a positive and significant non-linear effect in 8 Hour Cream. Thus, a few negative ratings may not increase the degree of price variation in 8 Hour Cream, but a large number of negative ratings will accelerate its price variation. Moreover, the estimates for BUYERFB show a negative and significant linear effect in the Second Class Stamps and a significant u-shaped effect in Harry Potter. Statistically, it indicates that the price dispersion is at the lowest when the number of buyer's feedback rating is about 76 in Harry Potter.

Regarding shipping charges, the coefficient estimates reveal the significant u-shaped effects in Sky Box and iPhone. The price variation for Sky Box approaches zero when the shipping cost is about £0.61. The data shows that the minimum postage in Sky Box is at £10 except a few auctions with almost free postage at £0.01. Thus, shipping cost has generally a positive linear effect in Sky Box. Similarly, the price dispersion is at zero when shipping cost is at £0.25 in iPhone. Since its minimum postage is at £3.50 apart from a very few auctions with almost free postage at £0.01, shipping cost has generally a positive and statistically significant impact in iPhone. In the First Class Stamps, the estimate for shipping has a negative and statistically effect at 10% significance level.

The impacts of gallery and picture features vary with the products. Seven out of ten coefficient estimates for GALLERY are positive, but only four estimates are statistically significant. PICTURE effects are statistically insignificant except GHD. In addition, the estimates for SETBIN show positive and highly significant effects for two out of three beauty products, while the estimates show the negative and significant effects for two expensive and expertise-required products, Sky Box and TomTom. Further, MULTI effects vary with the products. The coefficients are positive and statistically significant in 8 Hour Cream and Sky Box.

Overall, the results provide some useful insights on the price variations for each product. The price distributions depend on specific mixtures of observed and unobserved product and auction characteristics. Some products, such as Sky Box and TomTom, can mainly be explained by the independent variables, whereas sizeable price dispersions are still unexplained in the other categories. Table 8 compares the regressions of price dispersion under various measures. The AIC values indicate that the residual variance method and within-product regressions are better than pooled regressions. Given the data and a set of the models, the probability that i is the best model, w_i, shows that residual variance model provides the most plausible explanation for the price dispersion in the sample data. Pooled-level regressions lose information on analysing where the dispersion of prices comes from.

Table 8: Price Dispersion Model Selection with AIC

Model	K	AIC	$\triangle_i$	w_i
Residual Variance Method	204	-59.133	0	1
Price Dispersion Regressions (Characteristics)				
Coefficient of Variation	17	-1.913	57.220	3.757E-13
The Range	17	0.268	59.401	1.263E-13
The Gap	17	0.001	59.134	1.443E-13
SD of Normalised Price	17	-2.163	56.97	4.257E-13
Price Dispersion Regressions (Category Dummies)				
Coefficient of Variation	23	-2.011	57.122	3.946E-13
The Range	23	0.233	59.366	1.285E-13
The Gap	23	-0.041	59.092	1.473E-13
SD of Normalised Price	23	-2.300	56.833	4.559E-13
Price Dispersion Regressions within Products				
Coefficient of Variation	124	-24.610	34.523	3.187E-8
The Range	124	-12.677	46.456	8.170E-11
The Gap	124	-6.761	52.372	4.241E-12
SD of Normalised Price	124	-32.865	26.268	1.967E-6

Further, Table 9 shows that most of the products have nearly zero skewness. However, a large skewness of 2.64 in Sky Box indicates a right-skewed distribution, and a negative skewness of -1.44 in 8 Hour Cream shows a left-skewed distribution. Further, Sky Box has a very high kurtosis value of 32.19, which indicates that the price distribution has a very high peak and thin tails. This corresponds with the finding that Sky Box has the lowest price dispersion under most of the measures.

Table 9: Normality Test on the Residuals of the Product-Specific Regressions

Product	Obs.	Mean	Median	Max	Min	Std Dev	Skew	Kurt	Jarqu-Bera
Oral B	103	-1.07E-16	0.007	0.077	-0.134	0.045	-0.411	2.539	3.820
GHD	267	-7.16E-17	-0.001	0.173	-0.213	0.043	0.036	8.923	390.310
8HrCrm	86	4.23E-17	0.008	0.312	-0.779	0.156	-1.435	9.094	162.616
1st Cl	122	-1.98E-17	-0.009	0.439	-0.497	0.156	0.065	2.976	0.089
2nd Cl	148	1.07E-16	-0.023	0.491	-0.484	0.154	0.298	3.926	7.475
Sky Box	361	2.71E-17	-0.001	0.116	-0.090	0.014	2.644	32.188	13235.080
iPhone	84	8.26E-18	-0.002	0.389	-0.330	0.119	0.450	4.723	13.236
TomTom	147	2.27E-18	-0.007	0.232	-0.270	0.060	-0.167	8.790	205.995
HP	66	2.94E-17	-0.002	0.467	-0.477	0.128	-0.027	7.062	45.386
PS3	154	-3.01E-17	-0.001	0.233	-0.314	0.081	-0.092	4.674	18.205

Although some products are slightly left- or right-skewed, many categories reflect symmetric and normal-like distributions in Table 9. Even if there is no theory, the distributions of the residuals offer some indications on the origins of price dispersions. Each bidder can value a physically identical product differently. There is a valuation dispersion against the retail price in each product category. If most of the sellers add reserve prices in their auctions, one may expect that the distributions are skewed bumping up against the common value as a lower bound. However, seldom sellers of these physically identical products set reserves for their auctions. Indeed, eBay requires a minimum reserve price of GBP50 for any auctioned item and charges a non-trivial reserve-price fee regardless of whether the product is sold. Therefore, the shape of the distribution, which varies with the proportional sellers who add reserves in their auctions, ultimately depends on the charges of the reserve prices. Then, depending on the participants of a particular auction, the price of that auction may become slightly higher or lower. This 'random entry' is possibly one of the main reasons for the price dispersion of physically identical goods in the online auction markets like eBay. Then, different degrees of price dispersion across samples can be further explained by the specific product and auction characteristics.

Therefore, the residual variance method provides more explanations than the standard measures, since it reduces this randomness by allowing for the key factors at the first stage, during the price-level regression. This is consistent with the result of AIC model selection. Nonetheless, the method cannot eliminate bidders' random entry completely, although it helps to pick up the bidders' characteristics by group. Accordingly, price dispersion cannot be completely explained by the observed characteristics of the product and the auctions in that category.

4 CONCLUSION

Along the standard measures, this paper has suggested a new dispersion measure to investigate the degrees of price variation within and across 10 kinds of physically identical products on eBay. The results present some new evidence and possible explanations for the price variations in the online auction markets. The 'law of one price' has not prevailed in any sample category and sellers can avoid the Bertrand outcome, mainly because of the inevitable heterogeneities of consumers and sellers. Particularly, bidders' random entry cannot be eliminated completely. Thus, equilibrium price dispersions arise on eBay. However, consistent with some prior literature, such as Brynjolfsson and Smith (2000), Brown and Goolsbee (2002) and Ghose and Yao (2006), the levels of price and price dispersion on eBay are much lower than the ones reported in the prior literature regarding other online markets. It may be because that the analyses use the actual transaction data and/or increase market competitiveness on eBay. In particular, huge consumer participation on eBay has attracted offline retails to join eBay. This increases its market competitiveness and also hints the possible ability of eBay to extract rents from sellers, which in turn suggests that price dispersions arise in the online auction markets despite the fact that total consumer surplus may have increased by inducing competitive pricing and expanding product varieties.

The empirical findings under the standard measures and residual variance method are consistent. Specifically, the standard measures reveal that the distribution of prices of an expertise-required or soon-to-be-replaced product tends to be less dispersed, while it tends to be more dispersed for a daily-used product. It finds the highest levels of price dispersion for both First and Second Class Stamps and lowest degree of price dispersion for Sky Box. Also, the market dominated by the multi-channel sellers has generally a positive effect on the price variation.

The residual variance method further captures the insights on some linear and non-linear effects of product and auction characteristics that are not reflected under the standard measures. The results show that while some variables are significant on some products, others are significant on others. No one common factor influences the price dispersion for all the product categories consistently and persistently. The distributions of the residuals suggest that depending on the participants of a particular auction, the price of that auction may become slightly higher or lower. Taking bidders' random entry into account, different degrees of price dispersion across samples can be further explained by the observed product and auction characteristics using the residual variance method.

Given data and the candidate models, the model selection confirms that price dispersion regressions within products explain the observed price variations better than the pooled regressions with characteristic or category dummies, and the residual variance model provides the most plausible explanation for the price dispersions. However, the new method is still unable to explain the observed price dispersions completely.

Although this sample data has offered many advantages for examining online price dispersion, it has still certain limitations. The main one is the difficulty in controlling the number of sellers in the market. As discussed previously, the consumer demand and auction prices on eBay are not influenced by the number of sellers on any particular day but all the similar auctions during or even before the auction period. A continuum of sellers makes the study hard to predict about the relation between the number of sellers and the equilibrium price distribution. Nevertheless, the new measure still offers some important evidence on how and to what extent some systematic factors affect the levels of price and price dispersion in each category in the online auction markets.

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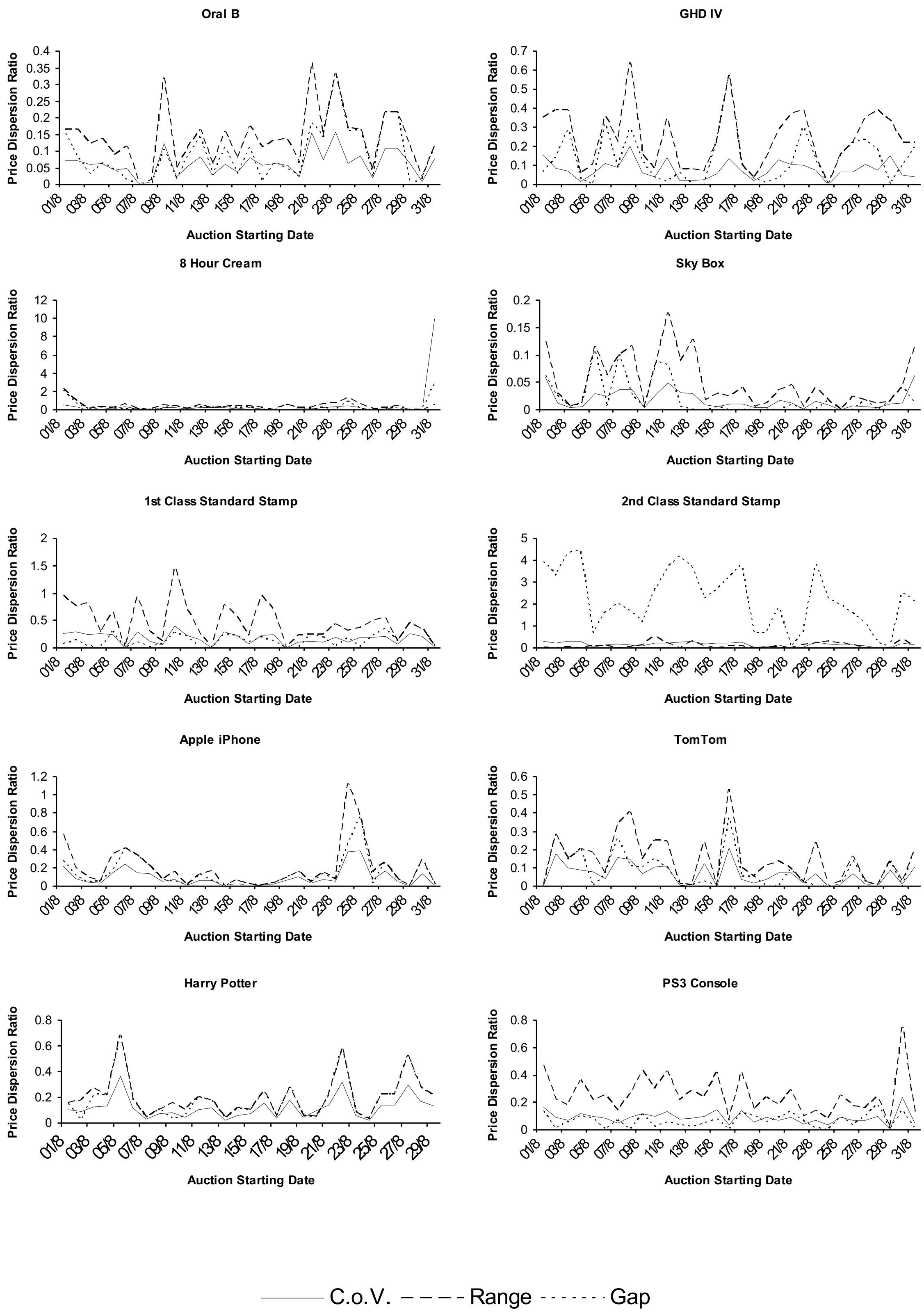
Appendix A: Summary Statistics of Empirical Literature on Online Price Dispersion

Study	**Product**	**Data Period**	**Region**	**C.o.V. (%)**	**Range (%)**	**Main Finding**
Bailey(1998a)	Books, CDs &Software	1997& 1998	US	$7.07 - 17.61$	-	Higher prices online and online price dispersion at least as great as offline
Brynjolfsson and Smith (2000)	Books & CDs	1998-1999	US	-	$25 - 33$	Lower price levels and smaller price adjustments online than offline; price dispersion levels depend on measures
Clay et al. (2001)	Books	1999-2000	US	$12.9 - 27.7$	$32 - 65$	C.o.V. falls as No. of sellers rise and the range rises with No. of firms, at least initially; prices of advertised/repeatedly purchased items lower than unadvertised infrequently purchased items
Lee and Gosain (2002)	Music CDs	1999-2000	US	-	old CDs: varied; new CDs:18-19 on/offline	Average percentage price difference online is not smaller than it is offline; and price dispersion depends on the product type
Baye et al.(2004)	Electronics	2000-2001	US	9.7	40	As No. of sellers increases, the range either increases or decreases; gap falls with No. of sellers with product popularity. C.o.V. falls as No. of sellers rise. Price dispersion varies across categories.
Brown and Goolsbee (2002)	Life Insurance	1992-1997	US	-	-	Price dispersion initially increases with No. of informed consumers but falls finally. Internet reduces term life prices by $8 - 15\%$.
Scholten and Smith (2002)	20 Products	1976&2000	US	12.87-14.5	-	Price dispersion online and offline at least as large in 2000 as it was in 1976;
Chen and Scholten (2003)	Computers, MP3 players, PDAs &Cameras	2001	US	$8 - 25$	$35 - 91$	Price dispersion varies across categories and the firm's behaviour varies with product characteristics which influences price dispersion.
Gatti and Kattuman (2003)	31 Products	2001-2002	EU	10.1	28	Price dispersion is lower for dearer products than cheaper products. Significant price dispersion across countries.
Ghose and Yao (2006)	4 categories	2000	US	$0.04 - 0.52$	-	Online price dispersion is as low as 0.04% under actual transaction prices. 'Law of one price' can prevail certain online markets.



Appendix B: Measured Dispersion Against Auction Starting Date

Appendix C: OLS Regression Results for Normalised Price Level within Sample Categories

	Dependent Variable: ln(PRICE/RRP)									
Independent Variable	Oral B	GHD	8 Hr Cream	1st Cls Stp	2nd Cls Stp	Sky Box	iPhone	TomTom	HP	PS 3
ln(MINBID)	-0.001	-0.005	0.227***	0.044***	0.021	0.004*	-0.001	0.001	0.025	-0.001
	(0.011)	(0.004)	(0.040)	(0.016)	(0.016)	(0.002)	(0.009)	(0.006)	(0.020)	(0.004)
ln(UB)	0.012	-0.060***	0.332***	0.025	0.115***	-0.005	0.056*	0.028	-0.015	0.024
	(0.009)	(0.013)	(0.063)	(0.047)	(0.042)	(0.006)	(0.032)	(0.018)	(0.061)	(0.015)
ln(DURATION)	0.091***	-0.006	0.103**	0.017	-0.084***	-0.001	0.064	-0.023*	0.026	0.053***
	(0.018)	(0.008)	(0.051)	(0.040)	(0.026)	(0.002)	(0.043)	(0.013)	(0.033)	(0.018)
ln(POS)	0.009	0.009***	0.015	-0.088***	-0.022*	0.007***	-0.035***	-0.001	0.047***	0.008*
	(0.011)	(0.003)	(0.019)	(0.016)	(0.013)	(0.001)	(0.013)	(0.006)	(0.017)	(0.005)
ln(NEG)	-0.013	-0.011*	0.027	0.055**	0.020	-0.006***	0.053*	-0.013*	-0.040	0.008
	(0.011)	(0.006)	(0.039)	(0.026)	(0.028)	(0.001)	(0.027)	(0.007)	(0.030)	(0.010)
ln(BUYERFB)	-0.002	-0.001	0.001	-0.012	-0.005	-0.001	-0.006	-0.001	-0.013	-0.012***
	(0.003)	(0.002)	(0.013)	(0.009)	(0.007)	(0.001)	(0.009)	(0.003)	(0.011)	(0.004)
ln(SHIPPING)	-0.018***	-0.001	-0.126**	-0.031***	-0.024***	0.010***	0.004	-0.024***	-0.003	-0.004
	(0.004)	(0.002)	(0.054)	(0.008)	(0.009)	(0.001)	(0.010)	(0.004)	(0.017)	(0.003)
WEEKEND	0.007	-0.015**	-0.068	-0.019	0.033	0.002	-0.001	-0.006	-0.064	-0.022
	(0.011)	(0.007)	(0.042)	(0.036)	(0.034)	(0.002)	(0.041)	(0.016)	(0.055)	(0.018)
PRIMETIME	0.025*	0.014**	0.019	0.042	-0.014	0.001	0.029	0.019*	0.005	-0.013
	(0.011)	(0.006)	(0.038)	(0.033)	(0.029)	(0.002)	(0.031)	(0.011)	(0.043)	(0.016)
GALLERY	0.009	0.041*	-0.035	0.112***	0.074**	0.008*	0.086	0.019	0.112	0.081***
	(0.031)	(0.024)	(0.061)	(0.035)	(0.030)	(0.004)	(0.073)	(0.035)	(0.070)	(0.022)
PICTURE	0.029	0.091**	-	-0.036	-0.202**	-	-	0.144***	0.029	-
	(0.062)	(0.039)		(0.061)	(0.079)			(0.046)	(0.162)	
SETBIN	0.099***	0.080***	0.142*	0.096	0.170**	-0.001	0.174***	0.222***	0.022	0.137***
	(0.024)	(0.022)	(0.080)	(0.091)	(0.073)	(0.008)	(0.062)	(0.034)	(0.106)	(0.032)
MULTI	-0.020	0.146***	0.170**	-	-	0.011**	-0.014	-0.096***	-0.200**	-0.067**
	(0.026)	(0.017)	(0.083)			(0.005)	(0.086)	(0.021)	(0.088)	(0.028)
CONSTANT	-1.019***	-0.405***	-1.533***	-0.098	-0.327**	-0.936***	0.159	-0.461***	-0.746***	-0.434***
	(0.072)	(0.048)	(0.169)	(0.156)	(0.135)	(0.016)	(0.137)	(0.063)	(0.219)	(0.053)
R-Squared	0.688	0.775	0.596	0.491	0.290	0.591	0.201	0.635	0.497	0.416
Adjusted R-Squared	0.643	0.763	0.529	0.434	0.227	0.577	0.066	0.599	0.372	0.367
Mean Dep Var	-0.719	-0.218	-0.679	-0.451	-0.583	-0.840	0.366	-0.309	-0.451	-0.220
SD Dep Var	0.081	0.092	0.245	0.219	0.183	0.022	0.133	0.100	0.180	0.106
SE of Regression	0.049	0.045	0.168	0.165	0.161	0.014	0.129	0.063	0.143	0.084
Akaike Info Criterion	-3.082	-3.334	-0.591	-0.671	-0.734	-5.610	-1.122	-2.596	-0.866	-2.033

Note: Standard errors are listed in parenthesis;
* represents 90% significance, ** represents 95% significance, *** represents 99% significance

Appendix D (a): Results of Tobit Estimations with Product-Characteristic Dummies

Dependent Variable: Measure of Price Dispersion				
Independent Variable	C.o.V.	Range	Gap	SD of Nor Price
ln(PRICE)	0.012	0.030	0.016	0.022***
	(0. 009)	(0.029)	(0.023)	(0.008)
ln(MINBID)	-0.006	-0.023	-0.013	0.002
	(0.006)	(0.021)	(0.017)	(0.006)
ln(UB)	0.020*	0.051	0.033	0.021**
	(0.011)	(0.033)	(0.026)	(0.009)
ln(DURATION)	-0.003	-0.014	0.034	-0.005
	(0.012)	(0.037)	(0.029)	(0.010)
ln(SELLERFB)	0.000	-0.004	0.004	-0.004*
	(0.003)	(0.008)	(0.006)	(0.002)
ln(BUYERFB)	0.001	-0.004	-0.017*	-0.001
	(0.004)	(0.012)	(0.010)	(0.003)
ln(SHIPPING)	0.003	0.008	0.001	0.001
	(0.006)	(0.018)	(0.014)	(0.005)
WEEKEND	0.026***	0.096***	0.013	0.016*
	(0.010)	(0.032)	(0.025)	(0.009)
PRIMETIME	-0.007	0.030	-0.028	-0.004
	(0.011)	(0.036)	(0.028)	(0.010)
GALLERY	0.022*	0.070*	-0.020	0.014
	(0.012)	(0.036)	(0.029)	(0.010)
PICTURE	0.034	0.154**	0.020	0.033*
	(0.021)	(0.065)	(0.052)	(0.018)
SETBIN	0.030***	0.112***	0.082***	0.015
	(0.010)	(0.032)	(0.026)	(0.009)
MULTI	0.015	0.041	0.052	0.013
	(0.013)	(0.040)	(0.032)	(0.011)
AGE	0.026	0.026	0.047	0.003
	(0.016)	(0.051)	(0.041)	(0.014)
EXPERTISE	-0.042**	-0.071	-0.118**	-0.087***
	(0.019)	(0.060)	(0.047)	(0.017)
DAILY	0.061***	0.199***	0.071	0.008
	(0.020)	(0.064)	(0.051)	(0.018)
LIFECYCLE	-0.057***	-0.125**	-0.076*	-0.033**
	(0.017)	(0.053)	(0.043)	(0.015)
Mean Dep Var	0.103	0.262	0.123	0.073
SD Dep Var	0.091	0.289	0.183	0.077
SE of Regression	0.079	0.251	0.179	0.071
Log Likelihood	312.676	-23.280	17.777	351.095
Akaike Info Criterion	-1.913	0.268	0.001	-2.163

Note: Standard errors are listed in parenthesis;
* represents 90% significance, ** represents 95% significance, *** represents 99% significance

Appendix D (b) Results of Tobit Estimations with Product-Category Dummies

Dependent Variable: Measure of Price Dispersion				
Independent Variable	C.o.V.	Range	Gap	SD of Nor Price
ln(PRICE)	0.024	0.055	-0.106	0.162***
	(0.049)	(0.159)	(0.125)	(0.042)
ln(MINBID)	0.001	-0.004	-0.010	0.009
	(0.006)	(0.021)	(0.016)	(0.006)
ln(UB)	0.014	0.031	0.030	0.017*
	(0.010)	(0.034)	(0.026)	(0.009)
ln(DURATION)	-0.023**	-0.063*	0.010	-0.027***
	(0.011)	(0.037)	(0.029)	(0.010)
ln(SELLERFB)	-0.005*	-0.009	-0.010	-0.005**
	(0.003)	(0.010)	(0.008)	(0.003)
ln(BUYERFB)	-0.006	-0.018	-0.021**	-0.007*
	(0.004)	(0.013)	(0.010)	(0.003)
ln(SHIPPING)	0.011	0.030	-0.013	0.016***
	(0.007)	(0.022)	(0.017)	(0.006)
WEEKEND	0.027***	0.098***	0.011	0.019**
	(0.009)	(0.030)	(0.024)	(0.008)
PRIMETIME	-0.006	0.030	-0.017	-0.004
	(0.010)	(0.034)	(0.027)	(0.009)
GALLERY	0.014	0.049	-0.018	0.008
	(0.011)	(0.036)	(0.028)	(0.010)
PICTURE	0.027	0.141**	0.037	0.019
	(0.020)	(0.064)	(0.050)	(0.017)
SETBIN	0.019*	0.085***	0.075***	0.006
	(0.010)	(0.032)	(0.026)	(0.009)
MULTI	0.026**	0.065	0.063**	0.017
	(0.012)	(0.040)	(0.031)	(0.011)
ORALB	0.021	0.007	0.714	-0.615***
	(0.211)	(0.690)	(0.538)	(0.183)
GHD	0.017	0.042	0.697	-0.631***
	(0.223)	(0.728)	(0.569)	(0.194)
8HR	0.163	0.379	0.626**	-0.232**
	(0.118)	(0.384)	(0.300)	(0.102)
1ST	0.165	0.378	0.594	-0.311**
	(0.157)	(0.513)	(0.401)	(0.137)
2ND	0.159	0.429	0.473	-0.257**
	(0.134)	(0.439)	(0.343)	(0.117)
SKY	0.079	0.071	0.585	-0.373***
	(0.152)	(0.495)	(0.387)	(0.132)
IPHONE	-0.032	-0.118	0.884	-0.845***
	(0.298)	(0.975)	(0.761)	(0.259)
TOM	-0.045	-0.170	0.748	-0.830***
	(0.268)	(0.874)	(0.683)	(0.233)
HP	-0.081	-0.228	0.671	-0.826***
	(0.254)	(0.828)	(0.648)	(0.220)
PS3	-0.056	-0.143	0.756	-0.899***
	(0.286)	(0.935)	(0.731)	(0.249)
Mean Dep Var	0.103	0.262	0.123	0.073
SD Dependent Var	0.091	0.289	0.183	0.077
SE of Regression	0.075	0.244	0.173	0.065
Log Likelihood	333.642	-11.949	30.319	378.183
Akaike Info Criterion	-2.011	0.233	-0.041	-2.300

Note: Standard errors are listed in parenthesis;
* represents 90% significance, ** represents 95% significance, *** represents 99% significance

Appendix E: Tobit Regression Results for Coefficients of Variation within Sample Categories

FULL SAMPLE ANALYSIS - 308 AGGREGATED OBSERVATIONS
Dependent Variable: Coefficient of Variation

Independent Variable	Oral B	GHD	8 Hr Cream	1st Cls Stp	2nd Cls Stp	Sky Box	iPhone	TomTom	HP	PS 3
ln(PRICE)	0.084	-0.049	-0.143	0.059	0.237***	0.091***	0.009	-0.017	0.027	0.045**
	(0.075)	(0.066)	(0.223)	(0.077)	(0.072)	(0.030)	(0.034)	(0.0254)	(0.054)	(0.021)
ln(MINBID)	-0.056	0.083	-0.037	0.038	-0.133***	-0.095***	-0.002	0.029	-0.008	-0.007
	(0.080)	(0.076)	(0.142)	(0.027)	(0.027)	(0.030)	(0.010)	(0.025)	(0.026)	(0.014)
ln(UB)	-0.039**	0.053***	-0.057	0.075	-0.170***	-0.028*	-0.042*	0.059***	-0.055	0.010
	(0.017)	(0.019)	(0.119)	(0.046)	(0.050)	(0.015)	(0.025)	(0.015)	(0.045)	(0.020)
ln(DURATION)	-0.003	-0.039***	0.207**	-0.063	0.004	0.000	0.134*	-0.030	0.013	-0.055*
	(0.021)	(0.014)	(0.093)	(0.088)	(0.060)	(0.006)	(0.077)	(0.021)	(0.029)	(0.032)
ln(SELLERFB)	-0.004	-0.002	-0.009	-0.011	-0.032*	0.010**	-0.049**	0.007*	0.011	-0.008
	(0.006)	(0.006)	(0.025)	(0.025)	(0.019)	(0.005)	(0.011)	(0.004)	(0.015)	(0.007)
ln(BUYERFB)	0.011	-0.007	0.019	-0.014	0.009	0.006	-0.025**	0.001	0.009	0.004
	(0.008)	(0.004)	(0.020)	(0.017)	(0.014)	(0.004)	(0.012)	(0.007)	(0.013)	(0.006)
ln(SHIPPING)	-0.027	0.012***	0.080	-0.012	-0.012	-0.025**	0.105**	-0.018	0.034	-0.036
	(0.022)	(0.004)	(0.075)	(0.038)	(0.027)	(0.013)	(0.044)	(0.022)	(0.044)	(0.029)
WEEKEND	-0.005	0.019*	0.104*	0.084**	0.089**	0.005	-0.027	0.031*	0.006	-0.002
	(0.014)	(0.010)	(0.054)	(0.038)	(0.036)	(0.005)	(0.035)	(0.016)	(0.039)	(0.014)
PRIMETIME	0.008	-0.006	0.062	0.008	0.001	0.009	-0.026	-0.069***	-0.088**	0.041*
	(0.014)	(0.018)	(0.050)	(0.048)	(0.038)	(0.008)	(0.029)	(0.019)	(0.039)	(0.023)
GALLERY	-0.035*	0.019	-0.022	0.056	-0.002	0.017**	-0.012	0.002	-0.073**	0.024*
	(0.018)	(0.012)	(0.051)	(0.046)	(0.031)	(0.008)	(0.043)	(0.022)	(0.037)	(0.012)
PICTURE	0.016	0.085***	-	0.005	0.012	-	-	0.089*	-0.071	-
	(0.035)	(0.020)		(0.048)	(0.033)			(0.047)	(0.074)	
SETBIN	0.004	-0.015	0.067	0.007	0.077*	0.016***	-0.031	0.001	0.022	0.047***
	(0.023)	(0.014)	(0.056)	(0.045)	(0.039)	(0.006)	(0.033)	(0.018)	(0.030)	(0.014)
MULTI	0.036**	0.010	0.112*	-	-	-0.008	0.198***	0.022	-0.055	0.017
	(0.017)	(0.017)	(0.068)			(0.007)	(0.049)	(0.019)	(0.058)	(0.018)
Mean Dep Var	0.064	0.077	0.163	0.175	0.163	0.018	0.094	0.065	0.120	0.090
SD Dep Var	0.038	0.048	0.121	0.102	0.094	0.017	0.099	0.057	0.085	0.044
SE of Regression	0.036	0.025	0.120	0.109	0.073	0.013	0.081	0.047	0.085	0.042
Log Likelihood	63.741	75.251	19.621	28.238	41.434	92.428	36.554	54.349	39.722	62.354
Akaike Info Criterion	-3.209	-3.952	-0.427	-0.983	-1.834	-5.124	-1.520	-2.603	-1.774	-3.184

Note: Standard errors are listed in parenthesis;
* represents 90% significance, ** represents 95% significance, *** represents 99% significance

Appendix F: Tobit Regression Results for the Ranges within Sample Categories

FULL SAMPLE ANALYSIS - 308 AGGREGATED OBSERVATIONS

Dependent Variable: The Range

Independent Variable	Oral B	GHD	8 Hr Cream	1st Cls Stp	2nd Cls Stp	Sky Box	iPhone	TomTom	HP	PS 3
ln(PRICE)	0.193	-0.195	-1.492**	0.290	1.131***	0.142	0.048	-0.043	0.034	0.117
	(0.168)	(0.204)	(0.671)	(0.264)	(0.345)	(0.090)	(0.091)	(0.060)	(0.105)	(0.073)
ln(MINBID)	-0.147	0.220	0.208	0.116	-0.377***	-0.164*	-0.009	0.062	-0.006	-0.018
	(0.180)	(0.232)	(0.426)	(0.093)	(0.129)	(0.089)	(0.027)	(0.058)	(0.051)	(0.049)
ln(UB)	-0.068*	0.123**	0.045	0.208	-0.640***	-0.052	-0.114*	0.129***	-0.098	0.029
	(0.039)	(0.057)	(0.357)	(0.158)	(0.240)	(0.044)	(0.069)	(0.037)	(0.090)	(0.068)
ln(DURATION)	0.002	-0.105**	1.202***	-0.143	-0.067	0.009	0.206	-0.070	0.022	-0.195*
	(0.046)	(0.044)	(0.281)	(0.305)	(0.289)	(0.019)	(0.207)	(0.054)	(0.057)	(0.110)
ln(SELLERFB)	-0.006	0.008	0.038	-0.080	-0.178*	0.034**	-0.111***	0.018*	0.023	-0.017
	(0.014)	(0.020)	(0.074)	(0.085)	(0.092)	(0.014)	(0.031)	(0.010)	(0.029)	(0.025)
ln(BUYERFB)	0.023	-0.003	0.033	-0.079	-0.032	0.010	-0.044	0.007	0.015	0.003
	(0.019)	(0.014)	(0.060)	(0.060)	(0.066)	(0.012)	(0.033)	(0.018)	(0.026)	(0.021)
ln(SHIPPING)	-0.060	0.024*	0.228	0.073	-0.032	-0.065*	0.219*	-0.048	0.056	-0.071
	(0.050)	(0.014)	(0.226)	(0.130)	(0.129)	(0.038)	(0.119)	(0.056)	(0.086)	(0.099)
WEEKEND	-0.004	0.0567*	0.348**	0.233*	0.354**	0.003	0.009	0.082**	0.023	-0.009
	(0.032)	(0.032)	(0.163)	(0.132)	(0.174)	(0.016)	(0.096)	(0.042)	(0.076)	(0.047)
PRIMETIME	0.0163	0.091	0.444***	0.125	0.100	0.025	-0.071	-0.130***	-0.156**	0.125
	(0.031)	(0.056)	(0.153)	(0.163)	(0.182)	(0.025)	(0.079)	(0.048)	(0.077)	(0.080)
GALLERY	-0.071*	0.026	-0.160	0.234	-0.135	0.043*	-0.068	-0.018	-0.128*	0.097**
	(0.040)	(0.038)	(0.154)	(0.158)	(0.150)	(0.024)	(0.117)	(0.057)	(0.073)	(0.042)
PICTURE	0.026	0.372***	-	0.101	0.151	-	-	0.240**	-0.090	-
	(0.078)	(0.063)		(0.166)	(0.159)			(0.122)	(0.145)	
SETBIN	0.019	0.024	0.310*	-0.082	0.201	0.037**	-0.088	0.032	0.044	0.144***
	(0.047)	(0.044)	(0.167)	(0.154)	(0.190)	(0.019)	(0.090)	(0.047)	(0.060)	(0.048)
MULTI	0.088**	0.051	0.314	-	-	0.007	0.517***	0.027	-0.154	0.026
	(0.037)	(0.053)	(0.204)			(0.021)	(0.134)	(0.048)	(0.113)	(0.061)
Mean Dep Var	0.138	0.241	0.429	0.462	0.502	0.050	0.197	0.142	0.200	0.250
SD Dep Var	0.087	0.158	0.453	0.348	0.396	0.048	0.245	0.133	0.159	0.149
SE of Regression	0.081	0.077	0.348	0.375	0.350	0.040	0.217	0.120	0.168	0.146
Log Likelihood	39.618	41.182	-9.219	-7.420	-5.686	59.878	7.740	26.810	20.019	24.001
Akaike Info Criterion	-1.653	-1.754	1.433	1.317	1.206	-3.024	0.339	-0.826	-0.415	-0.710

Note: Standard errors are listed in parenthesis;
* represents 90% significance, ** represents 95% significance, *** represents 99% significance

Appendix G: Tobit Regression Results for the Gaps within Sample Categories

FULL SAMPLE ANALYSIS - 308 AGGREGATED OBSERVATIONS

Dependent Variable: The Gap

Independent Variable	Oral B	GHD	8 Hr Cream	1st Cls Stp	2nd Cls Stp	Sky Box	iPhone	TomTom	HP	PS 3
ln(PRICE)	0.206	-0.222	-1.376*	0.162*	-0.042	0.223**	-0.052	0.042	0.025	0.097***
	(0.137)	(0.265)	(0.713)	(0.085)	(0.137)	(0.113)	(0.055)	(0.054)	(0.104)	(0.029)
ln(MINBID)	-0.168	0.161	0.152	0.022	-0.171***	-0.272**	-0.003	-0.002	-0.016	-0.035*
	(0.147)	(0.302)	(0.452)	(0.029)	(0.045)	(0.109)	(0.016)	(0.052)	(0.051)	(0.020)
ln(UB)	-0.118***	0.004	0.067	0.147***	-0.057	-0.104*	-0.051	0.121***	-0.110	-0.026
	(0.032)	(0.075)	(0.379)	(0.049)	(0.088)	(0.054)	(0.042)	(0.036)	(0.088)	(0.027)
ln(DURATION)	0.009	0.060	1.260***	-0.165*	0.204*	0.060***	0.350***	-0.031	0.043	-0.041
	(0.038)	(0.058)	(0.312)	(0.095)	(0.112)	(0.022)	(0.123)	(0.046)	(0.056)	(0.045)
ln(SELLERFB)	-0.007	-0.010	0.017	0.003	-0.015	0.048***	-0.085***	0.019**	0.030	-0.008
	(0.012)	(0.027)	(0.080)	(0.027)	(0.033)	(0.017)	(0.019)	(0.009)	(0.029)	(0.010)
ln(BUYERFB)	0.012	0.048***	0.029	-0.032*	0.014	-0.002	-0.042**	-0.037**	0.017	-0.007
	(0.015)	(0.018)	(0.063)	(0.019)	(0.024)	(0.014)	(0.020)	(0.016)	(0.026)	(0.009)
ln(SHIPPING)	-0.019	-0.018	0.148	-0.041	-0.037	-0.055	0.236***	-0.103**	0.043	-0.067*
	(0.041)	(0.018)	(0.241)	(0.041)	(0.048)	(0.043)	(0.072)	(0.049)	(0.085)	(0.040)
WEEKEND	-0.027	-0.086**	0.201	0.047	0.054	0.002	-0.093	0.020	-0.024	-0.017
	(0.027)	(0.043)	(0.178)	(0.042)	(0.066)	(0.020)	(0.057)	(0.035)	(0.075)	(0.019)
PRIMETIME	0.013	0.0144	0.316*	-0.131**	0.055	-0.005	0.010	-0.086**	-0.175**	0.030
	(0.025)	(0.073)	(0.164)	(0.052)	(0.067)	(0.030)	(0.047)	(0.040)	(0.076)	(0.033)
GALLERY	-0.110***	-0.024	-0.389**	-0.062	0.026	0.050*	0.007	0.032	-0.124*	0.009
	(0.034)	(0.049)	(0.167)	(0.050)	(0.056)	(0.027)	(0.069)	(0.047)	(0.072)	(0.017)
PICTURE	0.041	0.220***	-	0.002	-0.019	-	-	0.081	-0.157	-
	(0.065)	(0.081)		(0.053)	(0.054)			(0.110)	(0.144)	
SETBIN	0.001	0.107*	0.356**	0.015	0.083	0.053**	-0.041	0.046	0.038	0.043**
	(0.039)	(0.057)	(0.181)	(0.049)	(0.065)	(0.023)	(0.054)	(0.041)	(0.059)	(0.020)
MULTI	0.110***	0.210***	0.162	-	-	-0.027	0.308***	0.040	-0.212*	0.033
	(0.032)	(0.074)	(0.220)			(0.024)	(0.082)	(0.041)	(0.111)	(0.025)
Mean Dep Var	0.089	0.131	0.280	0.138	0.103	0.021	0.144	0.083	0.187	0.063
SD Dep Var	0.081	0.131	0.413	0.126	0.126	0.032	0.169	0.100	0.166	0.052
SE of Regression	0.063	0.094	0.333	0.113	0.108	0.033	0.130	0.072	0.166	0.052
Log Likelihood	41.119	28.373	-11.479	23.901	20.630	31.352	23.144	18.832	20.369	42.118
Akaike Info Criterion	-1.750	-0.927	1.579	-0.703	-0.492	-1.184	-0.654	-0.312	-0.439	-1.879

Note: Standard errors are listed in parenthesis;
* represents 90% significance, ** represents 95% significance, *** represents 99% significance

Appendix H: Tobit Regression Results for the Standard Deviations of the Normalised Prices within Sample Categories

FULL SAMPLE ANALYSIS - 308 AGGREGATED OBSERVATIONS

Dependent Variable: The Standard Deviation of the Normalised Price

Independent Variable	Oral B	GHD	8 Hr Cream	1st Cls Stp	2nd Cls Stp	Sky Box	iPhone	TomTom	HP	PS 3
ln(PRICE)	0.041	-0.043	-0.017	0.073	0.147***	0.039***	0.011	-0.014	0.046	0.037**
	(0.035)	(0.046)	(0.093)	(0.050)	(0.045)	(0.013)	(0.055)	(0.021)	(0.037)	(0.016)
ln(MINBID)	-0.026	0.068	-0.030	0.022	-0.071***	-0.041***	-0.005	0.028	-0.009	-0.004
	(0.038)	(0.053)	(0.059)	(0.018)	(0.017)	(0.013)	(0.016)	(0.020)	(0.018)	(0.011)
ln(UB)	-0.019**	0.042***	-0.037	0.049	-0.092***	-0.012*	-0.066	0.043***	-0.068**	0.009
	(0.008)	(0.013)	(0.050)	(0.030)	(0.031)	(0.006)	(0.042)	(0.012)	(0.031)	(0.015)
ln(DURATION)	0.001	-0.027***	0.077**	-0.071	-0.006	-0.001	0.235*	-0.023	0.018	-0.041*
	(0.010)	(0.010)	(0.039)	(0.057)	(0.037)	(0.003)	(0.124)	(0.016)	(0.020)	(0.024)
ln(SELLERFB)	-0.003	-0.001	-0.008	-0.010	-0.020*	0.004*	-0.089***	0.005*	0.004	-0.006
	(0.003)	(0.005)	(0.010)	(0.016)	(0.012)	(0.002)	(0.019)	(0.003)	(0.010)	(0.005)
ln(BUYERFB)	0.005	-0.005*	0.003	-0.011	0.001	0.003	-0.040**	0.002	0.002	0.003
	(0.004)	(0.003)	(0.008)	(0.011)	(0.009)	(0.002)	(0.020)	(0.005)	(0.009)	(0.005)
ln(SHIPPING)	-0.015	0.009***	-0.001	-0.014	-0.001	-0.011**	0.181**	-0.022	0.029	-0.035
	(0.010)	(0.003)	(0.033)	(0.025)	(0.017)	(0.006)	(0.072)	(0.016)	(0.030)	(0.022)
WEEKEND	-0.003	0.015**	0.072***	0.055**	0.057**	0.002	-0.045	0.025**	-0.013	-0.001
	(0.007)	(0.007)	(0.024)	(0.025)	(0.022)	(0.002)	(0.058)	(0.012)	(0.026)	(0.010)
PRIMETIME	0.004	-0.004	0.041*	-0.004	0.002	0.004	-0.035	-0.053***	-0.056**	0.032*
	(0.006)	(0.013)	(0.022)	(0.031)	(0.023)	(0.004)	(0.047)	(0.014)	(0.027)	(0.018)
GALLERY	-0.020**	0.016*	-0.007	0.024	-0.006	0.007**	-0.029	0.004	-0.058**	0.015
	(0.009)	(0.009)	(0.021)	(0.030)	(0.019)	(0.004)	(0.070)	(0.016)	(0.025)	(0.009)
PICTURE	0.009	0.065***	-	0.011	0.007	-	-	0.053	-0.035	-
	(0.017)	(0.014)		(0.031)	(0.021)			(0.035)	(0.050)	
SETBIN	0.000	-0.012	0.039*	0.008	0.037	0.007***	-0.060	-0.001	0.001	0.037***
	(0.010)	(0.010)	(0.023)	(0.029)	(0.025)	(0.003)	(0.054)	(0.014)	(0.021)	(0.011)
MULTI	0.019**	0.008	0.089***	-	-	-0.004	0.361***	0.014	-0.039	0.013
	(0.008)	(0.012)	(0.029)			(0.003)	(0.082)	(0.014)	(0.039)	(0.013)
Mean Dep Var	0.031	0.060	0.078	0.115	0.093	0.008	0.143	0.049	0.076	0.072
SD Dep Var	0.019	0.036	0.056	0.056	0.068	0.007	0.168	0.043	0.057	0.033
SE of Regression	0.018	0.018	0.052	0.071	0.045	0.006	0.129	0.035	0.058	0.032
Log Likelihood	90.336	85.887	42.610	40.769	55.627	117.323	22.816	62.887	50.739	70.871
Akaike Info Criterion	-4.925	-4.638	-1.974	-1.792	-2.750	-6.731	-0.633	-3.154	-2.534	-3.734

Note: Standard errors are listed in parenthesis;
* represents 90% significance, ** represents 95% significance, *** represents 99% significance

Appendix I(a): OLS Regression Results for Residual Variances within Products

	Dependent Variable: RESIDUAL^2				
Independent Variable	Oral B	GHD	8 Hr Cream	1st Cls Stp	2nd Cls Stp
ln(MINBID)	0.003	0.001**	-0.003	-0.000	0.002
	(0.004)	(0.000)	(0.036)	(0.004)	(0.004)
ln(MINBID)^2	-0.001	-0.001	-0.032*	0.000	-0.001
	(0.001)	(0.000)	(0.017)	(0.001)	(0.001)
ln(UB)	-0.001	0.002	0.019	0.018	0.037
	(0.001)	(0.003)	(0.049)	(0.039)	(0.037)
ln(UB)^2	0.001	0.001	-0.046*	-0.010	-0.016
	(0.001)	(0.001)	(0.025)	(0.013)	(0.013)
ln(DURATION)	0.004	-0.014	0.022	-0.033	-0.040*
	(0.022)	(0.010)	(0.182)	(0.034)	(0.023)
ln(DURATION)^2	-0.001	0.004	0.015	0.010	0.010
	(0.006)	(0.003)	(0.053)	(0.011)	(0.008)
ln(POS)	0.002	-0.001	0.067**	0.007	-0.026
	(0.002)	(0.001)	(0.026)	(0.021)	(0.017)
ln(POS)^2	-0.000	0.001*	-0.008***	-0.001	0.002
	(0.000)	(0.000)	(0.003)	(0.002)	(0.002)
ln(NEG)	-0.003	-0.003**	-0.001	-0.007	-0.014
	(0.004)	(0.002)	(0.026)	(0.016)	(0.015)
ln(NEG)^2	0.001	0.000	0.013**	0.006	0.003
	(0.001)	(0.000)	(0.005)	(0.007)	(0.008)
ln(BUYERFB)	0.000	0.000	0.014	-0.002	-0.013*
	(0.001)	(0.000)	(0.015)	(0.009)	(0.008)
ln(BUYERFB)^2	0.000	0.000	-0.002	-0.000	0.001
	(0.000)	(0.000)	(0.002)	(0.001)	(0.001)
ln(SHIPPING)	0.001	-0.002*	0.022	-0.033*	0.016
	(0.003)	(0.001)	(0.023)	(0.017)	(0.011)
ln(SHIPPING)^2	0.000	-0.001**	-0.021	0.025	-0.001
	(0.001)	(0.000)	(0.020)	(0.009)	(0.003)
WEEKEND	0.001	0.001**	0.008	-0.005	-0.002
	(0.001)	(0.001)	(0.014)	(0.008)	(0.009)
PRIMETIME	-0.001	0.000	-0.017	0.005	-0.018**
	(0.001)	(0.000)	(0.013)	(0.007)	(0.007)
GALLERY	-0.001	0.011***	-0.001	0.009	0.015**
	(0.002)	(0.002)	(0.021)	(0.007)	(0.008)
PICTURE	0.001	-0.030***	-	0.018	0.000
	(0.005)	(0.004)		(0.014)	(0.025)
SETBIN	0.001	0.006***	0.112***	-0.008	-0.007
	(0.001)	(0.002)	(0.032)	(0.032)	(0.028)
MULTI	0.000	-0.006***	0.129***	-	-
	(0.002)	(0.002)	(0.045)		
CONSTANT	-0.007	0.040***	-0.071	0.024	0.152***
	(0.025)	(0.009)	(0.199)	(0.075)	(0.057)
R-Squared	0.216	0.533	0.503	0.218	0.190
Adjusted R-Squared	0.025	0.495	0.360	0.072	0.070
SD Dep Var	0.003	0.005	0.069	0.034	0.040
SE of Regression	0.003	0.004	0.055	0.033	0.039
Akaike Info Criterion	-8.950	-8.250	-2.767	-3.842	-3.523

Note: Standard errors are listed in parenthesis;
* represents 90% significance, ** represents 95% significance, *** represents 99% significance

Appendix I(b): OLS Regression Results for Residual Variances within Products

	Dependent Variable: RESIDUAL^2				
Independent Variable	Sky Box	iPhone	TomTom	HP	PS 3
ln(MINBID)	-0.007***	-0.001	-0.005**	-0.001	-0.001
	(0.001)	(0.002)	(0.003)	(0.006)	(0.001)
ln(MINBID)^2	0.002***	0.000	0.001**	-0.002	0.000
	(0.000)	(0.001)	(0.001)	(0.002)	(0.000)
ln(UB)	0.004***	-0.018	0.018*	0.002	-0.007
	(0.001)	(0.023)	(0.009)	(0.068)	(0.007)
ln(UB)^2	0.000	0.007	-0.005*	-0.010	0.002
	(0.000)	(0.007)	(0.003)	(0.025)	(0.002)
ln(DURATION)	0.003***	-0.002	0.001	0.008	-0.021*
	(0.001)	(0.033)	(0.006)	(0.040)	(0.011)
ln(DURATION)^2	-0.001***	0.005	0.002	-0.003	0.006
	(0.000)	(0.011)	(0.002)	(0.017)	(0.004)
ln(POS)	-0.001***	-0.023**	0.003	0.008	0.002
	(0.000)	(0.010)	(0.003)	(0.020)	(0.002)
ln(POS)^2	0.000	0.002	-0.000	-0.000	-0.000
	(0.000)	(0.001)	(0.000)	(0.002)	(0.000)
ln(NEG)	0.001***	-0.005	-0.006**	0.000	-0.002
	(0.000)	(0.009)	(0.002)	(0.018)	(0.003)
ln(NEG)^2	-0.001***	0.000	0.001	-0.002	0.001
	(0.000)	(0.002)	(0.000)	(0.005)	(0.001)
ln(BUYERFB)	0.000	0.002	-0.001	-0.026**	0.001
	(0.000)	(0.006)	(0.001)	(0.010)	(0.002)
ln(BUYERFB)^2	0.000	-0.001	0.000	0.003*	-0.000
	(0.000)	(0.001)	(0.000)	(0.002)	(0.000)
ln(SHIPPING)	0.001***	0.011***	0.001	-0.002	0.001
	(0.000)	(0.003)	(0.001)	(0.020)	(0.001)
ln(SHIPPING)^2	0.001***	0.004***	-0.000	-0.001	0.000
	(0.001)	(0.001)	(0.005)	(0.000)	(0.000)
WEEKEND	0.000	0.001	-0.005**	-0.021	0.002
	(0.000)	(0.008)	(0.002)	(0.016)	(0.003)
PRIMETIME	0.000	0.007	-0.000	0.012	-0.001
	(0.000)	(0.006)	(0.002)	(0.012)	(0.002)
GALLERY	0.001***	0.003	0.016**	0.023	-0.006*
	(0.000)	(0.016)	(0.007)	(0.021)	(0.003)
PICTURE	-	-	-0.013	-0.002	-
			(0.008)	(0.047)	
SETBIN	-0.003***	-0.003	-0.010*	-0.006	-0.010
	(0.001)	(0.014)	(0.006)	(0.045)	(0.006)
MULTI	0.001*	-0.017	0.004	0.031	-0.002
	(0.000)	(0.038)	(0.003)	(0.036)	(0.005)
CONSTANT	-0.010***	0.014	-0.014	0.016	0.031**
	(0.001)	(0.055)	(0.013)	(0.107)	(0.013)
R-Squared	0.610	0.379	0.416	0.322	0.150
Adjusted R-Squared	0.589	0.194	0.324	0.020	0.029
SD Dep Var	0.001	0.027	0.010	0.040	0.012
SE of Regression	0.001	0.024	0.008	0.040	0.012
Akaike Info Criterion	-11.594	-4.385	-6.610	-3.369	-5.843

Note: Standard errors are listed in parenthesis;
* represents 90% significance, ** represents 95% significance, *** represents 99% significance

Appendix K: Interpretation of the Regression Results

K.1 Minimum Bid

The estimated squared residual of product i can be represented as follows:

$$\hat{u}_i^2 \quad = \quad a + b\ln(MINIBID) + c\ln(MINIBID)^2 \tag{.1}$$

K.1.1 Sky Box

According to Appendix I(b), in the case of Sky Box, Equation (1) becomes,

$$\hat{u}_{SkyBox}^2 \quad = \quad -0.007\ln(MINIBID) + 0.002\ln(MINIBID)^2 \tag{.2}$$

To find out the level of minimum bid that generates the optimal price dispersion for Sky Box, simply take the first derivative and set it equal to zero. Thus,

$$\begin{aligned} \frac{\partial \hat{u}_{SkyBox}^2}{\partial \ln(MINIBID)} &= -0.007 + 0.004\ln(MINIBID) = 0 \\ \ln(MINIBID) &= 1.75 \\ e^{1.75} &= 5.755 \end{aligned} \tag{.3}$$

Taking the second order condition gives $\frac{\partial^2 \hat{u}_{SkyBox}^2}{\partial \ln(MINIBID)^2} = 0.004 > 0$. Thus, the minimum bid in Sky Box has a u-shaped effect. The low and high levels of minimum bids have large dispersions, whereas those in between have smaller dispersions. Price dispersion for Sky Box is at the lowest when the minimum bid is at £5.76.

K.1.2 TomTom

Similarly, the equation for TomTom is

$$\hat{u}_{TomTom}^2 \quad = \quad -0.005\ln(MINIBID) + 0.001\ln(MINIBID)^2 \tag{.4}$$

Taking the first derivative and setting it equal to zero gives,

$$\begin{aligned} \frac{\partial \hat{u}_{TomTom}^2}{\partial \ln(MINIBID)} &= -0.005 + 0.002\ln(MINIBID) = 0 \\ \ln(MINIBID) &= 2.5 \\ e^{2.5} &= 12.182 \end{aligned} \tag{.5}$$

The positive second derivative gives $\frac{\partial^2 \hat{u}^2_{TomTom}}{\partial \ln(MINIBID)^2} = 0.002 > 0$. Similar to Sky Box, the price dispersion for TomTom is lowest when minimum bid is about £12.18.

K.2 Number of Unique Bidders

The effect of number of unique bidders on the estimated squared residual of product i is given:

$$\hat{u}^2_i = a + b\ln(UB) + c\ln(UB)^2 \quad (.6)$$

K.2.1 TomTom

Equation (6) becomes,

$$\hat{u}^2_{TomTom} = 0.018\ln(UB) - 0.005\ln(UB)^2 \quad (.7)$$

Taking the first derivative and setting it equal to zero gives,

$$\begin{aligned} \frac{\partial \hat{u}^2_{TomTom}}{\partial \ln(UB)} &= 0.018 - 0.01\ln(UB) = 0 \\ \ln(UB) &= 1.8 \\ e^{1.8} &= 6.050 \end{aligned} \quad (.8)$$

Taking the second order condition gives $\frac{\partial^2 \hat{u}^2_{TomTom}}{\partial \ln(UB)^2} = -0.01 < 0$. Thus, the price variation for TomTom is at its maximum when the number of unique bidders is about 6.

K.3 Auction Duration

The duration effect on the estimated squared residual of product i is shown as follows:

$$\hat{u}^2_i = a + b\ln(DURATION) + c\ln(DURATION)^2 \quad (.9)$$

K.3.1 Sky Box

Equation (9) becomes,

$$\hat{u}^2_{SkyBox} = 0.003\ln(DURATION) - 0.001\ln(DURATION)^2 \quad (.10)$$

Take the first order condition and set it equal to zero. Therefore,

$$\begin{aligned} \frac{\partial \hat{u}^2_{SkyBox}}{\partial \ln(UB)} &= 0.003 - 0.002 \ln(UB) = 0 \\ \ln(UB) &= 1.5 \\ e^{1.5} &= 4.482 \end{aligned} \tag{.11}$$

Given the negative second derivative, $\frac{\partial^2 \hat{u}^2_{TomTom}}{\partial \ln(UB)^2} = -0.002 < 0$, both short and long auctions have small dispersions, and those in between have larger dispersions. The dispersion is at the highest when the auction duration is about 3 or 5 days.

K.4 Positive Feedback

The estimated squared residual of product *i* is shown as follows:

$$\hat{u}^2_i = a + b \ln(POS) + c \ln(POS)^2 \tag{.12}$$

K.4.1 8 Hour Cream

Equation (12) becomes,

$$\hat{u}^2_{8HrCream} = 0.067 \ln(POS) - 0.008 \ln(POS)^2 \tag{.13}$$

Take the first derivative and set it equal to zero. Therefore,

$$\begin{aligned} \frac{\partial \hat{u}^2_{8HrCream}}{\partial \ln(POS)} &= 0.067 - 0.016 \ln(POS) = 0 \\ \ln(POS) &= 4.188 \\ e^{4.188} &= 65.891 \end{aligned} \tag{.14}$$

Given the negative second order condition, $\frac{\partial^2 \hat{u}^2_{8HrCream}}{\partial \ln(POS)^2} = -0.016 < 0$, the price variation for 8 Hour Cream has an n-shaped effect and it is largest when the number of seller's positive ratings is about 66.

K.5 Negative Feedback

The estimated squared residual of product *i* is shown as follows:

$$\hat{u}^2_i = a + b \ln(NEG) + c \ln(NEG)^2 \tag{.15}$$

K.5.1 Sky Box

Equation (15) becomes,

$$\hat{u}^2_{SkyBox} = 0.001\ln(NEG) - 0.001\ln(NEG)^2 \quad (.16)$$

Take the first order condition and set it equal to zero. Hence,

$$\begin{aligned} \frac{\partial \hat{u}^2_{SkyBox}}{\partial \ln(NEG)} &= 0.001 - 0.002\ln(NEG) = 0 \\ \ln(NEG) &= 0.5 \\ e^{0.5} &= 1.649 \end{aligned} \quad (.17)$$

Given the negative second derivative $\frac{\partial^2 \hat{u}^2_{SkyBox}}{\partial \ln(NEG)^2} = -0.002 < 0$, both low and high negative ratings generate small dispersions, whereas those in between have larger dispersions and it is the highest when the negative ratings are about 2.

K.6 The Feedback of a Buyer

The estimated squared residual of product i is shown as follows:

$$\hat{u}^2_i = a + b\ln(BUYERFB) + c\ln(BUYERFB)^2 \quad (.18)$$

K.6.1 Harry Potter

Equation (18) becomes,

$$\hat{u}^2_{HP} = -0.026\ln(BUYERFB) + 0.003\ln(BUYERFB)^2 \quad (.19)$$

Take the first derivative and set it equal to zero. Therefore,

$$\begin{aligned} \frac{\partial \hat{u}^2_{HP}}{\partial \ln(BUYERFB)} &= -0.026 + 0.006\ln(BUYERFB) = 0 \\ \ln(BUYERFB) &= 4.333 \\ e^{4.333} &= 76.172 \end{aligned} \quad (.20)$$

The second derivative gives $\frac{\partial^2 \hat{u}^2_{HP}}{\partial \ln(BUYERFB)^2} = 0.003 > 0$. The buyers' feedback has a u-shaped effect. The low and high levels of buyers' feedback have large dispersions. The dispersion is at the lowest when the number of the buyers' feedback ratings is about 76.

K.7 Shipping Cost The shipping cost effect on the estimated squared residual of product i is shown as follows:

$$\hat{u}_i^2 = a + b\ln(SHIPPING) + c\ln(SHIPPING)^2 \tag{.21}$$

.0.1 K.7.1 Sky Box

Equation (21) becomes,

$$\hat{u}_{SkyBox}^2 = 0.001\ln(SHIPPING) + 0.001\ln(SHIPPING)^2 \tag{.22}$$

Take the first order condition and set it equal to zero. It gives,

$$\begin{aligned} \frac{\partial \hat{u}_{SkyBox}^2}{\partial \ln(SHIPPING)} &= 0.001 + 0.002\ln(SHIPPING) = 0 \\ \ln(SHIPPING) &= -0.5 \\ e^{-0.5} &= 0.607 \end{aligned} \tag{.23}$$

Given the positive second order condition $\frac{\partial^2 \hat{u}_{1stamp}^2}{\partial \ln(SHIPPING)^2} = 0.002 > 0$, the estimate for shipping cost in Sky Box has a significant u-shaped effect and the price dispersion is at the lowest when the postage is £0.61.

.0.2 K.7.2 Apple iPhone

Equation (21) becomes,

$$\hat{u}_{iPhone}^2 = 0.011\ln(SHIPPING) + 0.004\ln(SHIPPING)^2 \tag{.24}$$

Take the first order condition and set it equal to zero. It gives,

$$\begin{aligned} \frac{\partial \hat{u}_{iPhone}^2}{\partial \ln(SHIPPING)} &= 0.011 + 0.008\ln(SHIPPING) = 0 \\ \ln(SHIPPING) &= -1.375 \\ e^{-1.375} &= 0.253 \end{aligned} \tag{.25}$$

Given the positive second order condition $\frac{\partial^2 \hat{u}_{iPhone}^2}{\partial \ln(SHIPPING)^2} = 0.008 > 0$, it has a u-shaped effect. The lowest level of dispersion is when the shipping cost is £0.25.