

Empirical Analysis on Price Level changes and Price Adjustment Policy Selection: Evidence from B2C E-commerce Market

Wei Zhang¹, Yan Chun Zhu^{2*} and Li Hua Wu³

¹*School of information, Central University of Finance and Economics, Beijing 100081, China*

²*School of Economics and Business Administration, Beijing Normal University, Beijing 100875, China*

³*School of Information Management, Beijing Information Science and Technology University, Beijing 100192, China*

Correspondence should be addressed to Yan Chun Zhu; kddzw@163.com

Abstract

The price war is the main market competition way for Chinese e-commerce retailers. Based on the price data from JD, Amazon and Dangdang, the paper conducted an empirical research on the price competition in B2C e-commerce market in China in terms of the average price level, minimum price level, price differential level and price variation. The research results show that the average price levels between the three e-commerce websites have significant differences. The minimum price level and the price differential level, however, tend to be similar. For the price variation, the three websites adopt different price adjustment strategies and do their best to avoid the direct price war, which reveals that the e-commerce market competition in China is gradually becoming rational.

Keywords: *B2C e-commerce market, Price competition, Price level, Price adjustment strategy*

1. Introduction

In recent years, Chinese e-commerce market has been growing fast. The sales volume of online shopping hit new records and its proportion to the total retail sales increased constantly. The data from iResearch shows that the sales volume of Chinese online shopping in the third quarter totaled 454.76 billion Yuan, increasing by 4.0 percent over that in the second quarter in 2013 and up 42.4 percent on last year's corresponding period. The year-on-year growth rate of online shopping sales is 3.2 times as much as that of the retail sales of consumption goods in the country (iResearch, 2013).

Despite of the fast development, the domestic e-commerce retailers are still stranded in the traditional circulation mode characterized by the large-scale and extensive management. The industry is rather homogeneous.

As the Internet giants and the traditional offline retailers speed up their expansion into the online business, the competition pattern in domestic e-commerce market marked with "two super power and multi-great power" is evolving over time and the competition will only intensify. The price war becomes a common-used weapon for e-commerce market competition. It leads to a series of problems such as impractically high sales, price speculations, frauds and so on. The corresponding services including logistics distribution, system and payment are not advanced enough to keep pace with the rising sales. How to get rid of the savage growth mode represented by price war, establish a new business model with healthy competition and cultivate the real core competitiveness become the urgent issues for the development of domestic e-commerce industry.

Many researches focused on the price competition in e-commerce market, especially on the price competition between e-commerce retailers and traditional offline retailers as well as online price competition. For the former, researchers usually explored the equilibrium prices

and profits between two parties by using information economics theories and game theories to establish models (Chen Yun *et. al.* 2006, Pan *et. al.*2002, Zhao Liqiang 2011). The models were often verified by using examples or simulation experiments and need further investigated by using empirical data (Ba *et. al.* 2012). Some researchers hence collected the price data of some commodities, *e.g.* CDs, books and software in e-commerce market. Compared with offline channels, they concluded the lower pricing strategies in online direct selling through statistical analyses and tests (Friberg *et. al.* 2000, Brynjolfsson *et. al.* 2000). Nonetheless, these researches paid little attention on the price competition tendency between e-retailers. As the impact of online channel on traditional channel on the goods such as books and music gradually increased, the academia began to be concerned about the price competition between e-retailers. For example, taking Amazon and Barnes & Noble bookstore as research subjects, Judith *et. al.* (2003) explored the pricing strategies under duopoly competition from the aspects of price dispersion and price elasticity by employing methods such as regression analysis, maximum likelihood estimate and so on. Their research revealed that both e-retailers are sensitive to the price, but the price elasticity of demand of Barnes & Noble bookstore is significantly higher than that of Amazon. The limitations on the data size (only two e-commerce retailers) and the product category (only book goods), however, influence the universality of the research's results (Ba *et. al.* 2008).

Aiming at the status quo of vicious price competition between domestic e-commerce retailers, this paper explores the pricing modes, pricing strategies and pricing features of e-commerce retailers from four aspects including the average price level, minimum price level, price differential level and price variation by collecting and analyzing the actual price data of e-commerce retailers. The research will provide an empirical basis on establishing the positive competition environment and mechanism for e-commerce retail market.

2. Related Work

Two aspects of the price competition in e-commerce market are mainly addressed through a lot of theoretical and empirical researches. At first, to investigate the effects of e-commerce implementation level on the price competition behaviors of retailers, researchers analyzed the price competition between e-commerce retailers and traditional offline retailers and established competition models to discuss the equilibrium prices acceptable by two parties by using information economics theories and game theories. For example, Chen Yun *et. al.* (2006) established a two-stage game model to analyze the price competition behaviors of e-commerce retailers and traditional offline retailers. They made out the optimal price, equilibrium profit and customers' distribution states both under online and offline cases. They pointed out that the profits made by e-commerce retailers will be higher than that made by traditional retailers when the e-commerce implementation level reaches some critical value. The work of Chen Yun *et. al.* didn't consider the influences of the online behavioral differences of consumers and dual channels on the price competition. To address this problem, Pan *et. al.* (2002) built a price competition game model based on Hotelling model under the case where internet outlets and dual channels coexist and summarized that online direct sellers generally adopt lower pricing strategies than offline sellers. Considering different consumers and two kinds of price competition strategies of Bertrand and Stackelberg, Zhao Liqiang(2011) used game theory to research the equilibrium prices and profits of e-commerce retailers and traditional offline retailers based on the demand functions established by using consumer utility theory. His research was verified with a numerical example and showed that traditional retailers tend to choose the preempting Stackelberg strategy to ensure greater commercial interests when they are faced with the competition from e-commerce retailers.

The researches above promoted the cognitions on the price competition between e-commerce retailers and traditional offline retailers. But these researches employed game theories based on deductive logic and the hypotheses and results need to be further verified by empirical arguments (Ba *et. al.* 2012). Some researchers therefore used the price data of some commodities, *e.g.* CD, books and software in e-commerce market and statistics methods to quantitatively describe the competition tendency of online and offline retail price, and they found that the online prices are lower than the offline prices (Friberg *et. al.* 2000, Brynjolfsson

et. al. 2000).

With the expansion of e-commerce retail market, the academia begins to be concerned about the price competition between e-retailers. For example, in virtue of the best selling data of books, Judith and Austan (2003) analyzed the price competition between Amazon and Barnes & Noble online bookstore and found that both sides are sensitive to the price, but the price elasticity of demand of Barnes & Noble bookstore is significantly higher than that of Amazon. Ghose and Gu (2008) revealed the reasons for the above phenomenon from the perspectives of the demand structure of consumers and market friction. They thought that when the price of books reduced, the price elasticity of Amazon rose while Barnes & Noble fell since Amazon has the advantages of lower cost of price information searching and higher customer loyalty. Also, Ba *et. al.* (2007) used game theories to construct the duopoly competition model. They obtained the price competition strategies under the cases where both the service level of online retailers and the brand's cognitions are different and found the reverse price effect appeared in the price competition in online retail market. On the basis of the work above, Ba *et. al.* (2008) built the oligopoly model to analyze the conditions leading to the reverse price effect further under the case of vertical differences and gave the corresponding suggestions on pricing strategies. However, the hypotheses on the homogenization in the cost structure of online retailers in the model were too simple to measure the heterogeneities of consumers, hence affected the applicability of the results (Lin Xudong 2009, Guo 2013).

3. Empirical Research

3.1. Data Selection and Collection

According to the annual monitoring report on the Chinese online shopping industry for 2012-2013 years (iResearch Consulting Group, 2013), this paper selects three self-operating e-commerce retailers, namely JD (www.Jd.com), Dang(www.dangdang.com) and Z.cn (Amazon.cn), as subjects for the empirical research (the three websites holds 55.1% market share in Chinese self-operating B2C business). Based on the product categories in Amazon, product samples are selected. And then the same products are chosen from the other two websites. 11 categories of products are used as research subjects totally. 235171 pieces of price data on 515 kinds of products from October 15, 2012 to April 15, 2013 are collected.

3.2. Average Price Level Analysis

(1) Multiple comparisons

Hypothesis 1: There is a significant difference between the average price of JD and Amazon, and the former's average price is lower than the latter's.

Hypothesis 2: There is a significant difference between the average price of Dangdang and JD, and the former's average price is lower than the latter's.

Hypothesis 3: There is a significant difference between the average price of Amazon and Dangdang, and the former's average price is lower than the latter's.

Based on the price sample data, the single factor analysis of variance on the overall average price level is carried out first and Welch is used to test the results. The conclusions are summarized in Table 1 and Table 2.

Table 1. Single Factor Variance Test Results (Overall Average Price)

| | Mean | JD | Z.CN | Dang | Sig |
|---------------|---------|---------|---------|---------|------|
| average price | 1141.32 | 1161.64 | 1058.43 | 1210.03 | .000 |

* denotes the result is significant at 0.05 level; ** denotes the result is significant at 0.01 level; *** denotes the result is significant at 0.001 level

Table 2. Multiple Comparison Analysis Results (Overall Average Price)

| Websites | Mean Difference | Sig. |
|-------------------|-----------------|------|
| JD vs.Z.CN | 103.207*** | .000 |
| JD vs.Dangdang | -48.393*** | .000 |
| Z.cn vs. Dangdang | -151.600*** | .000 |

* denotes the result is significant at 0.05 level; ** denotes the result is significant at 0.01 level; *** denotes the result is significant at 0.001 level

According to Table 1 and Table 2, the average prices of JD, Amazon and Dangdang are 1161.64, 1058.43, and 1210.03 respectively; there is a significant difference between the average price of JD and Amazon, $p < 0.001$, and the former's average price is higher than the latter's; there is a significant difference between the average price of JD and Dangdang, $p < 0.001$, and the former's average price is lower than the latter's; there is a significant difference between the average price of Amazon and Dangdang, $p < 0.001$, and the former's average price is lower than the latter's. Therefore, Hypothesis 1, 2, and 3 are refused, that is to say the overall average price level of JD is lower than that of Dangdang and Amazon.

Next, the single factor variances of 11 categories of products are analyzed by using Welch test method in the view of product category. The results are shown in Table 3 and Table 4.

Table 3. Single Factor Variance Analysis Results (Product Category)

| Category | average price (JD) | average price (Z.cn) | average price (Dang) | Sig | Note |
|-------------------|--------------------|----------------------|----------------------|------|----------------------|
| Book | 72.22 | 41.83 | 46.66 | .000 | JD > DANG > Z.CN |
| TV | 5119.14 | 5296.88 | 4883.02 | .000 | Z.cn > JD > DangDang |
| Air conditioning | 3626.15 | 3839.94 | 3755.63 | .000 | Z.cn > DangDang > JD |
| Refrigerator | 1563.13 | 1761.48 | 1835.76 | .000 | DangDang > Z.cn > JD |
| washing machine | 2339.11 | 2347.93 | 2096.53 | .000 | Z.cn > JD > DangDang |
| Smart phone | 1425.68 | 1380.47 | 1487.36 | .000 | DangDang > JD > Z.cn |
| digital product | 2505.01 | 2429.95 | 2531.23 | .155 | DangDang > JD > Z.cn |
| Laptops | 3955.09 | 4887.57 | 4623.31 | .000 | Z.cn > DangDang > JD |
| Health&Beauty | 173.7 | 73.78 | 170.16 | .000 | JD > DangDang > Z.cn |
| Maternal and Baby | 250.16 | 200.39 | 259.26 | .000 | DangDang > JD > Z.cn |
| food | 309.63 | 77.52 | 530.29 | .000 | DangDang > JD > Z.cn |

* denotes the result is significant at 0.05 level; ** denotes the result is significant at 0.01 level; *** denotes the result is significant at 0.001 level

From the average price comparisons of four kinds of household electrical appliances, the average prices of Amazon are higher than the other two websites in a big part of product categories. But the price differences between Amazon and JD are not significant.

In the 3C digital product market, JD's average prices are significantly lower than the other two websites for notebook computers while Amazon's average prices are the significantly lowest for mobile phone and digital products; and Dangdang's average prices are the significantly highest for all the 3C digital products. Thus for the 3C digital products which are the main source of profit of JD, JD don't adopt the low price competition strategy completely. In fact, JD has built up certain approval and loyalty for the 3C digital product among customers, and reduced the price sensitivity of customers.

In the general merchandise market, all price differences are significant except for maternal and infant products between JD and Dangdang. The average prices of the three kinds of merchandises in Amazon are the significantly lowest. The reason may lie in the absolute price advantage of Amazon since Amazon is a comprehensive e-commerce website and its purchase cost and operation cost of general merchandises are lower than the other two websites.

(2) Average price analysis by time period

By setting the 15th of each month as the boundary, the price data from October 15, 2012 to

April 15, 2013 are divided into six time periods. The first period includes the data from October 15, 2012 to November 15, 2012; the second period is from November 16, 2012 to December 15, 2012, and so on. The single factor variance analysis and the multiple comparison test of average price are performed by time period. The results are shown in Table 5 and Table 6.

Table 5. Single Factor Variance Analysis Results (Average Price by Time Period)

| Time period | Mean | JD | Z.cn | DangDang | F value | Sig |
|-------------|---------|---------|---------|----------|------------|------|
| t1 | 1138.68 | 1062.10 | 1062.76 | 1087.84 | 9.492*** | .000 |
| t2 | 1051.80 | 1102.27 | 1004.46 | 1047.49 | 4.298* | .013 |
| t3 | 1114.34 | 1169.66 | 1022.51 | 1174.47 | 19.762*** | .000 |
| t4 | 1202.77 | 1137.39 | 1039.96 | 1440.16 | 108.391*** | .000 |
| t5 | 1185.86 | 1246.35 | 1090.30 | 1240.20 | 32.182*** | .000 |
| t6 | 1226.19 | 1184.69 | 1093.56 | 1405.17 | 67.820*** | .000 |

* denotes the result is significant at 0.05 level; ** denotes the result is significant at 0.01 level; *** denotes the result is significant at 0.001 level

Table 6. Multiple comparison Test Results (Average Price by Time Period)

| Time period | Websites | Mean Difference | Sig. |
|-------------|---------------|-----------------|------|
| t1 | JD-Z.cn | 76.582*** | .000 |
| | JD-DangDang | 75.915*** | .000 |
| | Z.cn-DangDang | -.667 | .974 |
| t2 | JD-Z.cn | 97.805** | .004 |
| | JD-DangDang | 54.776 | .081 |
| | Z.cn-DangDang | -43.029 | .176 |
| t3 | JD-Z.cn | 147.155*** | .000 |
| | JD-DangDang | -4.805 | .871 |
| | Z.cn-DangDang | -147.155*** | .000 |
| t4 | JD-Z.cn | -302.775*** | .001 |
| | JD-DangDang | 97.432*** | .000 |
| | Z.cn-DangDang | -97.432*** | .000 |
| t5 | JD-Z.cn | 156.048*** | .000 |
| | JD-DangDang | 6.141 | .793 |
| | Z.cn-DangDang | -156.048*** | .000 |
| t6 | JD-Z.cn | -220.477*** | .001 |
| | JD-DangDang | 91.135*** | .000 |
| | Z.cn-DangDang | -91.135*** | .000 |

* denotes the result is significant at 0.05 level; ** denotes the result is significant at 0.01 level; *** denotes the result is significant at 0.001 level

From the results of Table 5, except the price differences of three websites in the second time period are significant at 0.05 level ($p=0.014$), the price differences of three websites in the other time periods are significant at 0.001 level. So there are significant price differences between the three websites.

From the results of Table 6, the price differences between three websites in the fourth and sixth time periods are significant ($p \leq 0.001$). And in the other time periods, there are always the cases where the average price differences are not significant between two-two comparisons. The cases where the average price differences are not significant between JD and Dangdang appears three times and two times between Amazon and Dangdang. The average price differences between JD and Amazon, however, are always significant. So the price competition between three websites is rather obvious, especially the price competition between Dangdang and JD.

3.3. Minimum Price Level Analysis

To perceive the price level of various kinds of products in the three websites comprehensively, this paper conducts the empirical analysis on the minimum price level and the ANOVA test results are shown in Table 7.

Table 7. Single Factor Variance Analysis Results (Minimum Price)

| | All products | Best-seller | Non-best-seller |
|---------|--------------|-------------|-----------------|
| F value | .012 | .015 | .015 |
| Sig | .988 | .986 | .979 |

* denotes the result is significant at 0.05 level; ** denotes the result is significant at 0.01 level; *** denotes the result is significant at 0.001 level

As shown by Table 7, there are no significant differences between the product minimum prices of the three websites. Even the products are divided into the best-seller and non-best-seller, the product minimum prices of the three parties are not significantly different yet.

To make a detailed understanding of the minimum price differences in different kinds of products in three e-commerce websites, the single factor variance analysis on each product category is performed individually. The ANOVA test results are shown in Table 8.

Table 8. Single Factor Variance Analysis Results on Different Product Category (Minimum Price)

| | Book | TV | Refrigerator | Smart phone | Laptops |
|---------|------|------|--------------|-------------|---------|
| F Value | .105 | .002 | .032 | .003 | .041 |
| Sig | .901 | .998 | .969 | .997 | .960 |

* denotes the result is significant at 0.05 level; ** denotes the result is significant at 0.01 level; *** denotes the result is significant at 0.001 level

Table 8 indicates that there are no significant differences between the product minimum prices of five kinds of products including book, TV, refrigerator, mobile phone and notebook computer in the three websites ($p > 0.05$). The results reveal that domestic online shopping consumers are still sensitive to the minimum price. So to increase website's click-through rates and flows and then the sales, e-commerce retailers look upon the minimum price as the important way to attract consumers, which leads to the price competition in e-commerce retail market more intensively.

3.4. Price Differential Level Analysis

The price differential means the difference between the maximum price and the minimum price of a product. The single factor variance analyses on the price differential level of three websites are conducted. The ANOVA test results are shown in Table 9 and Table 10.

Table 9. Single Factor Variance Analysis Results (Price Differential)

| | All products | Best-seller | Non-best-seller |
|---------|--------------|-------------|-----------------|
| F value | 1.242 | .265 | 1.305 |
| Sig | .293 | .768 | .280 |

* denotes the result is significant at 0.05 level; ** denotes the result is significant at 0.01 level; *** denotes the result is significant at 0.001 level

Table 10. Single Factor Variance Analysis Results on Different Product Category (Price Differential)

| | Book | TV | Refrigerator | Smart phone | Laptops |
|---------|-------|------|--------------|-------------|---------|
| F value | 1.571 | .071 | .643 | .702 | 5.228 |
| Sig | .226 | .932 | .536 | .509 | .019* |

* denotes the result is significant at 0.05 level; ** denotes the result is significant at 0.01 level; *** denotes the result is significant at 0.001 level

According to the results in Table 9 and Table 10, the price differentials of various kinds of products in different websites are not significant ($p > 0.05$). The ANOVA test results on different product categories indicate that the price differentials of all kinds of products in the three websites have no statistical significance ($P > 0.05$) except for notebook computer product. The results verify the conclusions on the minimum price level, that is to say the price competition between three websites are quite intensive.

4. Conclusions

The price war is the most common and unreasonable competition way in domestic e-commerce industry currently. To reveal the characteristics of price competition between domestic e-commerce retailers, this paper employs the quantitative methods to analyze the features and differences of price strategies adopted by e-commerce retailers from four aspects of the average price level, minimum price level, price differential level and price variation based on the empirical price data from three self-operating e-commerce retailers. The empirical results show that the price is still the primary factor influencing the online shopping behaviors of consumers, and the e-commerce retailers take the price as the main competition way too. For five product categories including book, TV, refrigerator, mobile phone and notebook computer in JD, Amazon and Dangdang websites, there are significant differences in the average price level while no significant differences in the minimum price level and price differential level. As for price variation, JD adopts all three kinds of price adjustment strategies including periodical price adjustment, holiday price adjustment and seasonal price adjustment, while Amazon and Dangdang adopt the holiday price adjustment strategy and seasonal price adjustment strategy respectively. Moreover, there exists obvious inconsistency in the time points where the three e-commerce retailers carry out their price adjustment strategies. The fact implies that there exists price collusion to some degree between e-commerce retailers, and the industry competition inclines to be rational. E-commerce retailers are resuming their nature to make profits and trying their best to avoid being lost in the price wars. However, this paper only focuses on the Chinese B2C e-commerce retailers who mainly operate their business by themselves. At the same time, the time span for data collection is short (only six months), and the product category sample is relatively small too. All of these restrict the comprehensive research on the dynamical price evolution over a year in the e-commerce retail market, and so influence the universality of empirical results. In future, the other B2C retailers such as Suning.com, Tmall.com, yhd.com, yixun.com and Tencent will be taken into consideration and the time span of data will be extended so that the samples can cover the main e-commerce retailers wider and the implications and the evolution laws of price competition in Chinese e-commerce market can be explored further.

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Authors



Wei Zhang, (1976)- School of information, Central University of Finance and Economics, Beijing 100081, China.



Yan Chun Zhu, (1979)-School of Economics and Business Administration, Beijing Normal University, Beijing 100875, China.



Li Hua Wu, (1977-)- School of Information Management, Beijing Information Science and Technology University, Beijing 100192, China.