
Search costs in electronic markets: market equilibrium and corporation strategy

Jian Chen* and Yingxia Lin

Research Center for Contemporary Management, School of Economics
and Management, Tsinghua University, Beijing, 100084, China

Fax: 86-10-62785876

E-mail: jchen@tsinghua.edu.cn E-mail: linyx2@em.tsinghua.edu.cn

*Corresponding author

Abstract: In this paper, a model is built to analyse the influences of search costs on market equilibrium. According to the results of a simulation, we conclude that the equilibrium prices of e-markets are not always lower than those of conventional markets, especially under certain combinations of return costs and search costs. In addition, some managerial insights are derived from the simulation results, e.g., that information technology doesn't always create intensive price competition. Companies can soften competition in many ways in the e-market, such as differentiating themselves on the basis of search costs.

Keywords: Search cost; e-market; conventional market; market equilibrium.

Reference to this paper should be made as follows: Chen, J. and Lin, Y. (2003) 'Search costs in electronic markets: market equilibrium and corporation strategy', *Int. J. Electronic Business*, Vol. 1, No. 1, pp.83-93.

Biographical notes: Jian Chen received a BSc degree in Electrical Engineering from Tsinghua University, Beijing, China in 1983, and both an MSc and a PhD degree in Systems Engineering from the same University in 1986 and 1989, respectively. He is a Professor and Chairman of the Management Science Department, as well as being co-director of the Research Center for Contemporary Management, Tsinghua University. Dr. Chen has over 90 technical publications. His main research interests include decision support systems and information systems, e-business, forecast and optimisation techniques and supply chain management. He serves as a member of various committees and boards including the Editorial Advisory Board of the *International Journal of Electronic Business*.

Yingxia Lin received a BSc Degree from Tsinghua University, Beijing, China, in 2002. She is currently pursuing an MSc degree in management science from the same university.

1 Introduction

The swift development of information technology has had a great influence on the economy, structure and administration of companies. In particular, the application of the internet builds an electronic market for transactions. As is well known, building an

electronic market for transactions is one of the special applications of the internet, which facilitates more frequent and convenient communications between consumers and sellers.

In recent years, efforts have been taken to study the consequent distribution of value between consumers and companies. One popular opinion is that, with the development of e-markets, the consumer's surplus will be increased and the seller's surplus will be decreased. The market will finally evolve into a frictionless state [1,2]. However, in terms of some research results, prices of e-markets are not always lower than those of conventional markets. For example, Lee [3] analysed the second-hand car market in Japan and found that the price of used cars auctioned in the e-market is higher than in the conventional market; Bailey [4,5] did research on products, such as books, CDs and software in the Boston area and he also indicated that the e-market's price is higher. Then, how does a company make a profit in an e-market? Have the purchase patterns of consumers been changed? More and more scholars focus on search theory to answer the above questions, for search theory is mainly concerned with the expenditures involved in the search process and it is the reduction of such expenditures that makes the e-market attractive [6].

The idea presented in this paper is to some extent influenced by some previous search models [7–11]. Although their models differ from each other, they all discuss an important variable – search costs. Generally speaking, search costs refer to expenditures spent by customers in order to get the relative information, such as locations and credits of the sellers, prices and qualities of the products. However, while applying the variables of search cost into models, the specific definitions of them are different.

Hotelling Model [8], which is the first search model proposed by Hotelling in 1929, regarded travel costs, which mainly refer to transportation fees, as consumers' search costs and pointed out that search cost is a source of monopolisation. But it did not take the factor of sellers, which might influence the search cost as well, into account. Although Salop [12], Bakos [7], Zettlemeyer [11], Rajav Lal [9] improved Hotelling's model and included the influence of sellers on search costs in their models, their definitions of search cost did not differ much in essence from Hotelling's.

The inventive idea of this paper is that we divide search costs into two parts: one is called systematic search cost represented by the variable t , and the other is non-systematic search cost represented by the variable s . Systematic search cost is the cost of accessing a seller and negotiating the price, which may occur in every purchase, and is a feature of markets. Both transportation fees and calling fees belong to this part. Generally speaking, buying the products in a conventional market would cost consumers a greater systematic search cost than in an e-market. On the other hand, non-systematic search cost isn't an innate feature of markets and can be controlled by sellers. They can manipulate this part of search costs in many ways, like the products' design, marketing, the layout of product-selling homepages and so on. The more the products deviate from the norm, the higher this kind of cost is. The non-systematic search cost is optional, which means that consumers may buy a product before knowing its exact utilities.

The model described in this paper mainly discusses the equilibrium of oligarch markets because in real life most product markets are oligarchic. That is to say, in most product markets, the number of big producers is relatively small, but they control most of the market, just like Microsoft, GE etc.

In this paper, we begin with the model description in Section 2 and analyse it in Section 3. From the analyses we elicit several managerial implications in Section 4 and come to a conclusion as well as some further study directions in Section 5.

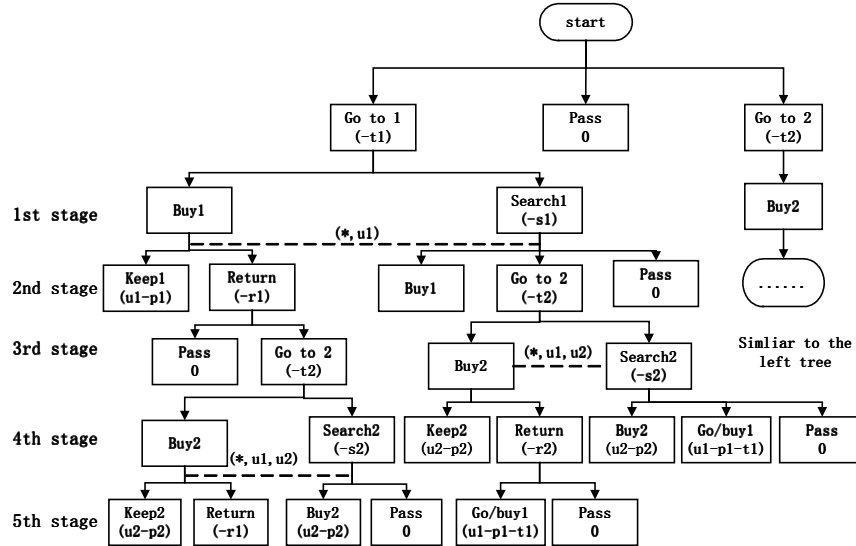
2 Model description

This model assumes there are two firms in the market who are selling the same kind of products. The first one represents the leaders in the oligarch market whilst the second represents the followers who are relatively powerless. Every consumer is buying at most one item from the two sellers. We assume there is no difference of quality between the products of the two sellers, but there may be some non-quality differences, such as the appearance and the design of the products. Consumers know the prices p_i , the systematic search costs t_i , and the non-systematic search costs s_i (in this model, we assume $p_i, t_i, s_i \in X = [0,1]$, $i=1,2$), but they don't know the gross utilities they will derive from the product. They are, however, aware of the distribution pattern of the utility, which is distributed uniformly between 0 and 1 ($u_i \sim U[0,1]$, $i=1,2$). And u_i is independent of u_j ($i,j=1,2$).

Figure 1 shows the search pattern of consumers. In each node of Figure 1, consumers have to choose an action from the action set according to the expected utility of each one. For example, consider the node 'Go to 2' in the third stage, if the expected utility of the node 'Buy 2' is greater than that of the node 'Search 2', then consumers should choose 'Buy 2' instead of 'Search 2' in the fourth stage. And different nodes may have different action sets. For example, after buying the seller 1's product in the first stage, consumers can only choose to keep the item or return it. So the node 'Buy 1' in the first stage has an action set: {Keep 1, Return 1}. If the consumer in the first stage chooses to search at seller 1, he can decide whether to buy, to go to seller 2, or to pass after searching seller 1. Therefore, the node 'Search1' has a different action set: {Buy 1, Go to 2, Pass}. Consumers can return the dissatisfying products to get their money back but they must pay the return costs r_i ($r_i \in [0,1]$, $i=1,2$), which also represent a feature of markets. There is no possibility for consumers to return the item if they do buy it after searching, because we assume each customer is rational enough that he wouldn't pay for the dissatisfying item after knowing the exact utility of it. Since we consider seller 1 as the leader of the market, it is reasonable to assume all the consumers would choose 'Go to 1' at the start point.

In the model, there are two decision variables for both sellers: the prices p_i , $i=1,2$ and the non-systematic search costs s_i , $i=1,2$. The decision-making process is a two-stage perfect-information game. Firstly, the sellers must seek the price equilibrium under a certain combination of non-systematic search cost. Secondly, after solving the problem of the sub-game equilibrium, we can get the non-systematic search cost equilibrium and it becomes the equilibrium for the whole problem ($s_1^*, s_2^*, p_1^*, p_2^*$).

Figure 1 The search tree of consumers



- (i)"i" (i=1,2) refers to seller i. For example, "Buy i" (i=1,2) means that consumers buy the products from seller i
- (ii)"Pass" means that the consumers leave the market and don't buy anything.
- (iii)The nodes connected by "----" have the same information set which is indicated by the content in the bracket above "----". For example, after buying or searching the products from seller 1 in the first stage, the consumers know the exact value of u_1 . And the nodes "Buy 1" and "Search 1" are connected to show that they have the same information about u_1

3 Model analysis

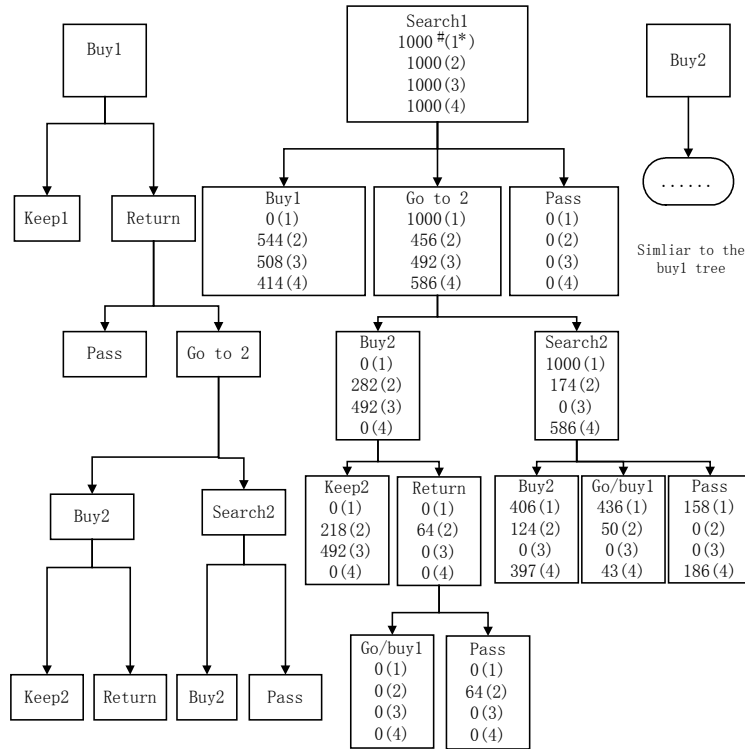
Figure 1 shows that the searching pattern is quite complicated. The seller must consider the possible actions of customers as well as his competitor's. And it is very hard to find the exact expression of the equilibrium. So we consider an alternative way, simulation, to study this problem. In simulation, the feasible set X is approximated by a discrete set X' ($X' = \{0, \frac{1}{N}, \frac{2}{N}, \dots, 1\}$, and N depends on the required accuracy, e.g., $N=100$ or 10000). Under each combination of non-systematic search cost, the payoff matrix (as shown in Figure 2) is calculated out, based on which the Nash Equilibrium of prices can be obtained. After solving the problem of the sub-game equilibrium, we can derive an overall payoff matrix of non-systematic search costs. And the simulation result of equilibrium $(s_1^*, s_2^*, p_1^*, p_2^*)$ is the Nash equilibrium of this overall matrix, which is approximate to the exact equilibrium $(s_1^*, s_2^*, p_1^*, p_2^*)$.

As mentioned before, this model uses two variables in order to describe the innate features of the market: systematic search cost and return cost. It is commonly assumed that the systematic search cost is less in an e-market than that in a conventional market [6,7] and that return cost is determined by the traits of the products. For products that are consumed quickly and with less value, the corresponding return costs are lower.

Table 2 The simulation results

Cases	Equilibrium		
	Prices	Non-systematic search cost	Payoff
$C_1=(t_i = 0, r_i = 0)$	$p_1^* = 0.4$ $p_2^* = 0.4$	$s_1^* = 0$ $s_2^* > 0$	$g_1(p_1^*, p_2^*) = 174.4$ $g_2(p_1^*, p_2^*) = 162.4$
$C_2=(t_i = 0.1, r_i = 0)$	$p_1^* = 0.2$ $p_2^* = 0.2$	$s_1^* = 0$ $s_2^* > 0$	$g_1(p_1^*, p_2^*) = 118.8$ $g_2(p_1^*, p_2^*) = 68.4$
$C_3=(t_i = 0, r_i = 0.5)$	$p_1^* = 0.5$ $p_2^* = 0.5$	$s_1^* = 0$ $s_2^* > 0.125$	$g_1(p_1^*, p_2^*) = 254.0$ $g_2(p_1^*, p_2^*) = 246.0$
$C_4=(t_i = 0.1, r_i = 0.5)$	$p_1^* = 0.4$ $p_2^* = 0.3$	$s_1^* = 0$ $s_2^* = 0$	$g_1(p_1^*, p_2^*) = 182.8$ $g_2(p_1^*, p_2^*) = 119.1$

Figure 3 The simulation result



*:the number in the bracket is indicative of case $i(i=1, 2, 3, 4)$
#:the number before the bracket shows how many customers who choose the corresponding action

3.1 Low search cost, low return cost ($t_i = 0, r_i = 0$)

When the return cost $r_2 = 0$ and the non-systematic search cost $s_2 > 0$, it is easy to see that the expected utility of ‘Buy2’ in the third stage

$U_{buy2} = \int_0^1 \max(u_2 - p_2, \max(u_1 - p_1 - t_1, 0) - r_2) du_2$, is greater than that of ‘Search2’ in the

same stage, $U_{search2} = \int_0^1 \max(u_2 - p_2, u_1 - p_1 - t_1, 0) du_2 - s_2$. As a result, the action ‘Buy2’ is

superior to the action ‘Search2’. Also, when $s_1 = 0$, the action ‘Search1’ is superior to the action ‘Buy1’ in the first stage, which can also be derived from the comparison of their expected utilities. Therefore, it is shown in Figure 3 that all the consumers would choose ‘Search1’ in the first stage and ‘Search 2’ in the third stage. That is to say, every consumer wouldn’t buy the product directly, but select to explore the relative information about the product before buying it.

3.2 High search cost, low return cost ($t_i = 0.1, r_i = 0$)

As we mentioned before, the equilibrium of case C_1 is regarded as the equilibrium in e-markets and the equilibrium of case C_2 is regarded as the one in conventional markets. Comparing these two equilibriums, we can find their differences as follows:

- 1 The higher systematic search cost ($t_i = 0.1, i=1,2$) will hinder the consumers from searching and buying the product of the seller whom the customers have not arrived at. For example, in case C_2 , there are only 456 persons choosing ‘Go to 2’ in the second stage after searching seller 1. While in case C_1 , all the persons choose ‘Go to 2’ in order to search at seller 2.
- 2 When $t_i = 0.1, i=1,2$ the equilibrium price is lower. The equilibrium price of case C_1 is ($p_1^* = 0.4, p_2^* = 0.4$) whilst equilibrium price of case C_2 is ($p_1^* = 0.2, p_2^* = 0.2$). That means the price of the e-market is higher than that of the conventional market. From simulation, when $t_2 \neq 0$, consumers express less interest in the product of seller 2. So, in order to attract more customers, he has to lower the price, and seller 1 will react to seller 2’s action by lowering price too. To some extent, it brings a price war between two sellers. Consequently, the equilibrium price falls.

Compare the payoff of each seller in cases C_1 and C_2 , we find that seller 2’s gain decreases much more than seller 1’s gain does. And it is all because of the higher systematic search cost. So if seller 2 changes the sale pattern from the conventional way to the electronic way (i.e., decreases his systematic search cost), what will happen to the market equilibrium? Our simulation results show that when $t_1 = 0.1, t_2 = 0, r_i = 0, i=1,2$, the equilibrium price will be ($p_1^* = 0.4, p_2^* = 0.4$), and the payoff of each seller is ($g_1(p_1^*, p_2^*) = 119.6, g_2(p_1^*, p_2^*) = 204.0$). So if seller 2’s systematic search cost falls while seller 1’s systematic search cost remains the same, the equilibrium of the market will evolve into a state that greatly benefits seller 2 and in this state, the competition will be softened as well. This result is very meaningful. When the return cost is low, the market followers can resort to information technology to make up the loss caused by

difficult search in conventional markets and use the sale pattern of B to C to make search easier for the consumers and increase the sale and the payoff, as well.

3.3 Low search cost, high return cost ($t_i = 0, r_i = 1/2$)

From Figure 3, we see that the expected utility of ‘Buy2’ is higher than that of ‘Search2’ in the third stage. Therefore, the expected utility# of ‘Go to 2’ in the second stage is

$$U_{\text{goto2}} = U_{\text{buy2}} = \int_0^1 (u_2 - p_2^*) du_2 = 0.5 - p_2^* \quad (1)$$

And the expected utility of ‘Buy1’ in the second stage is

$$U_{\text{buy1}} = u_1 - p_1^* \quad (2)$$

Compare equations (1) and (2), customers will choose ‘Go to 2’ when $u_1 \in [0, \frac{1}{2} + p_1^* - p_2^*]$ (i.e., $u_1 \in [0, \frac{1}{2}]$, since $p_1^* = 0.5, p_2^* = 0.5$); they will choose

‘Buy1’ when $u_1 \in [\frac{1}{2} + p_1^* - p_2^*, 1]$ (i.e., $u_1 \in [\frac{1}{2}, 1]$). That is, after searching seller 1,

customers with higher u_1 such that $u_1 \in [\frac{1}{2}, 1]$ would buy at seller 1, whilst others (with lower u_1) would go to seller 2. In addition, because seller 2 set a higher value of non-systematic search cost (i.e., $s_2 > 0.125$), every consumer who goes to seller 2 will buy his product without searching and keep it due to the high return cost.

Compared with case C_1 , the payoff of each seller in case C_3 is higher. Seller 2 utilises the market feature – high return cost and intentionally set high non-systematic research cost to lock-in the consumers who would originally not buy his products after finding out their exact utilities. Therefore, seller 2 also gains a very high payoff.

3.4 High search cost, high return cost ($t_i = 0.1, r_i = 0.5$)

Similarly, we regard the equilibrium of C_3 as the one in e-markets and C_4 as the one in conventional markets. The differences between these two cases are:

- 1 The payoff decreased from $(g_1(p_1^*, p_2^*) = 254.0, g_2(p_1^*, p_2^*) = 246.0)$ in case C_3 to $(g_1(p_1^*, p_2^*) = 182.8, g_2(p_1^*, p_2^*) = 119.1)$ in case C_4 . And the loss of seller 2 is greater than that of seller 1.
- 2 To some extent, seller 2’s lower price helps to offset the negative influence caused by the high systematic search cost so that more consumers like to go to seller 2 in the third stage in case C_4 than in case C_3 .
- 3 In case C_4 , because the equilibrium non-systematic search cost of seller 2 is zero, he lacks the ability to lock-in consumers. Therefore, some consumers pass after searching the products of seller 2.

Similar to what we have pointed out in Section 3.2, we find that if the systematic search cost of seller 2 is lower in a high-return-cost market, which means that seller 2 realises electronic transactions first, the results of the simulation indicate that the payoff of seller 2 will also be increased.

On the other hand, if it is seller 1 who realises electronic transactions first, the simulation results are ($s_1^* = 0$, $s_2^* > 0.8$, $p_1^* = 0.5$, $p_2^* = 0.4$) and the equilibrium payoffs for both sellers increase to ($g_1(p_1^*, p_2^*) = 251.5$, $g_2(p_1^*, p_2^*) = 198.8$). Seller 2 sets a low price to attract the customers, and locks-in the customers by setting a high non-systematic search cost. In this way, seller 2 also gains high profits. This equilibrium result is similar to the conclusion derived from Zettlemeyer's model [11]. In that paper, he points out that in the market there exists an equilibrium: one firm offers a high price but makes search easy while the other firm prevents most consumers from searching but offers a lower price, which gives some suggestions to the followers that if the leaders first realise electronic transaction, they had better lower the price and differentiate the products, because differentiating the products would increase the non-systematic search cost to lock-in the consumers who would originally not buy the products after knowing the exact utilities.

4 Managerial implications

From the simulation results based on the model proposed in this paper, some managerial implications can be drawn.

In a low-return-cost market, the higher systematic search cost, such as the transportation fee and the calling fee, may cause the followers in the market to gain less. Comparing cases C_1 and C_2 , we find that if this kind of search cost is high, people are relatively unwilling to search and buy the products of the less famous producer, i.e., the follower's products. And even after buying the follower's products, because the return cost is low, many consumers would choose to return the dissatisfying items. So in a low-return-cost market, the higher systematic search cost is a disadvantage to the followers. It is recommended that they invest in technologies, e.g. the internet, to make searching easier, and lower the systematic search cost. In case C_2 , the simulation results also point out that the follower can put the leader into a disadvantageous circumstance by realising the information technology first. Therefore, the leader should utilise the technology to consolidate their power in the market.

In a high-return-cost market, the comparison of cases C_3 and C_4 also show that the higher systematic search cost is a disadvantage to the followers. And the application of information technology can benefit the followers and the leaders to some extent. In addition, and different from the low-return-cost market, our results show that in the high-return-cost market followers might choose to differentiate themselves to increase the non-systematic search cost. Since the non-systematic search cost is very high, the consumers would buy the products directly without knowing the exact utility of the products. Moreover, the high return cost would keep the consumers from returning the dissatisfying products after buying them. In this way, the followers lock-in the consumers who might originally not buy the products after knowing the exact utilities of them. Even

if the leaders build the electronic transaction market firstly, the followers can also differentiate themselves to defend themselves from their competitors.

In both kinds of markets, each case C_i suggests that the price war should be avoided because it would lead to a low equilibrium price and the profit of each party would be reduced. To gain the advantage when in competition, every seller should try to reduce his production costs as well as ineffective expenditure on marketing and service etc. Furthermore, they can use the economies of scale and cost advantages to set barriers for entering companies.

5 Conclusion

This paper presents a model in which firms set not only prices but also non-systematic search costs. Consumers know the price of goods but are uncertain about their willingness to pay for the goods. By searching at a firm they learn about their willingness to pay at that firm.

It is shown that new technologies, e.g. the internet, which makes searching easier, can benefit the sellers both in low-return-cost markets and in high-return cost-markets. And this paper contributes to the marketing and economics literature by showing the ways in which firms can strategically use consumer search cost to enhance their performance in making profits.

Although the model brings us some insightful outcomes, much work remains to be done in the future based on our current study. In this model, it is assumed that u_i ($i = 1, 2$) are independent of each other. However, in real life, this assumption isn't always true, which should be considered in a further study. Also, the model can be extended to discuss the problem that some consumers purchase repetitively.

Acknowledgement

The authors would like to thank the editor for his valuable comments and suggestions. This work was supported in part by the National Science Foundation of China (NSFC) under Grant No. 79825102, the Fund for Ph.D. Disciplines (Grant No. 2000000322) and the Basic Research Fund of the School of Economics and Management of Tsinghua University (2001002).

References

- 1 Brynjolfsson, E. and Smith, M.D. (2000) 'Frictionless commerce? A comparison of internet and conventional retailers', *Management Science*, Vol. 46, No. 4, pp.563–585.
- 2 Kutter, R. (1998) 'The net: a market too perfect for profits', *Business Week*, 11 May, Vol. 12.
- 3 Lee, H-G. (1998) 'Do electronic marketplaces lower the price of goods', *Communications of the ACM*, Vol. 41, No. 1, pp.73–80.
- 4 Bailey, J.P. (1998) 'Electronic commerce: prices and consumer issues for three products: books, compact discs, and software', *Technical Report OECD/GD(98)4*, Organization for Economic Cooperation and Development.

- 5 Bailey, J.P. (1998) 'Intermediation and electronic markets: aggregation and pricing in internet markets', *Management and Policy, Doctoral Dissertation*, Massachusetts Institute of Technology.
- 6 Malone, T.W., Yates, J. and Benjamin, R. (1987) 'Electronic markets and electronic hierarchies', *Communications of the ACM*, Vol. 30, No. 6, pp.484-497.
- 7 Bakos, J.Y. (1997) 'Reducing buyer search cost: implication for electronic marketplaces', *Management Science*, Vol. 43, No. 12, pp.1676-1692.
- 8 Hotelling, H. (1929) 'Stability in competition', *Economic Journal*, Vol. 39, No. 1, pp.41-57.
- 9 Rajiv L. and Sarvary, M. (1998) 'Does the internet always intensify price competition', *Research Paper No.1457R*, Stanford University, 2 April.
- 10 Tirole, J. (1988) *The Theory of Industrial Organization*, MIT Press.
- 11 Zettlemeyer, F. (1998) 'The strategic use of consumer search cost', *Working Paper*, University of California, Berkeley.
- 12 Salop, S. (1979) 'Monopolistic competition with outside goods', *Bell Journal of Economics*, Vol. 10, No. 1, pp.141-156.