Strategic Investment Decisions of the E-commerce Platforms in Switching Barrier

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Abstract: This paper develops a users' transferring model to study the impact of the user loyalty heterogeneity on the investment decisions of the E-commerce platforms in switching barrier. We carry out sensitivity analysis of optimal investment in the parameters to explore how to adjust investment decisions based on the change of disloyal users' proportion when the economic environment changes. We find that the switching cost always makes it beneficial to the leader *A*; while the high relative investment capability of *B* decreases its disadvantage and makes its behavior more aggressive. In addition, the user loyalty heterogeneity is beneficial to the superior who has the investment advantage in a profitable market. Specifically, although the investment in switching barrier can relax the competition, high market profitability not only intensifies the competition, but also increases the relative investment advantage, and the follower *B* may own a comparative advantage and its behavior is aggressive.

Keywords: switching barrier; investment decisions; switching cost; proportion of the disloyal users

1 Introduction

In the E-commerce markets, the third party provides e-platforms for the buyers and sellers to make their transactions, which ensure the fairness, security and efficiency [1]. The third party e-platforms make profits by periodically taking fixed fees from users and users conduct transactions on the platform to get profits. However, users are unstable and they will switch to other platforms once the expected profit target of transaction cannot be achieved on the platform. The switching influences the revenue of the third party platform. It is strongly supported by series of studies that the users who have transaction relationships with a third party platform may have barriers when switching to other platforms, especially in the E-commerce environment. Switching barrier is described as the factors making it difficult for the users to transfer, and it contains three aspects: switching cost, interactional relationship and substitute attraction [2], [3] and its detail elements are explained by Fornell [4].

From the satisfaction and loyalty's perspective, many publications have devoted much effort to detecting the effects of switching barrier on equilibrium outcome, especially on the price decision [5], [6]. The switching barrier is a significant resource in enterprise competitiveness, i.e., the switching barrier can make it difficult for the users to transfer, which can raise the user retention and relax competition [7], [8]. Accordingly, it is worthy for the third party to make investment in switching barrier. However, although the platform may make strategic effort investments to gain a competitive advantage in user retention, its competitors may very aggressively seek to prevent the investing platform from acquiring a larger market share and the user loyalty heterogeneity may make the situation much more serious. The user loyalty heterogeneity is a key factor to retain the relationship between customers and suppliers [9], which could enhance switching barrier and influence the investment decisions [10]. The impact of the user loyalty heterogeneity on users' retention was investigated [11]. Also, the strategic investment decisions in switching barrier are affected by the user loyalty heterogeneity, so it is necessary to focus on the issue that how to adjust the decisions continuously based on the change of disloyal users' proportion.

However, few models have been conducted on the strategic investment decisions in switching barrier in the E-commerce environment, and most researches ignored the impact of the user loyalty heterogeneity on the investment decisions. This paper focuses on the impact; and we carry out the sensitivity analysis of optimal investment and investigate how to adjust investment decisions based on the change of disloyal users' proportion

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when the economic environment changes. This paper concludes with a discussion of the results and some directions for future research.

2 The model and optimization

2.1 The model development

Consider a duopolistic third party market consisting of two firms denoted by leader *A* and follower *B*. A user chooses a platform to make his transaction and obtain revenue *R*. Similar to Berbardo et al. [12], we assume that the revenue function of the user is $R = k\theta e$, where θ (e) represents the investment capability (the investment level) in switching barrier of platforms, and the coefficient k is the market profitability. Assume that the follower *B* has a higher investment capability (i.e., $\theta_B > \theta_A$). We use $\theta_A^B = \theta_B / \theta_A$ to represent the relative investment capability of follower *B* to leader *A*.

Similar to Xue et al. [13] and Demirhan et al. [14], we assume that the users are heterogeneous in loyalty and divide them into three types named by loyal users, shoppers and new users with the proportions being (1-*u*-*v*), *u* and *v*, respectively.

Before choosing platforms, the users should estimate the profits and compare them. They always choose the platform with maximal expected profit and switch to other platforms that can provide higher expected profit. The loyal users are stable, on the contrary, the shoppers are always more fickle-minded whatever the initial choice is. Assume that the market scale is a constant, i.e., if a fraction *v* of the users leave the market, they will be replaced by the same number of new users.

The switching barrier contains three aspects: switching cost c_s, interactional relationship (1-*u*-*v*) and substitute attraction $k_1(\theta_A e_A - \theta_B e_B)$ [5]. The main issue on strategic investment decisions in switching barrier for a platform is to decide and adjust the investment which may influence the substitute attractions and interactional relationships based on its investment capability. However, there are different opinions whether the switching cost is influenced alike or not. Lots of studies showed that the switching cost has a multi-dimensional construct, and its elements are very complex and correlative [15]. Incorporating users' loyalty heterogeneity, we regard the switching cost as the net utility of superiors on condition that neither of the duopoly invests in switching barrier. Apparently, the switching cost is independent of the investment decisions, which is consistent with the literature [6], [13], [16]. For simplicity, we assume that only the switching users from leader *A* have the switching cost c_s, which does not affect our main results.

The market is represented by a horizontally differentiated line segment [0, 1] with *A* and *B* at 0 and 1[17]. The users' choice preferences to a platform can be denoted by *x*. We assume that the preferences are uniformly distributed on the line [0, 1]. A user always incurs a utility loss of b per unit distance between its ideal point and the actual one, so the utility loss at position *x* is *bx*. Assume that the users have to pay a fixed fee α per period. Thus, the user's net utility of platform is $R - \alpha - bx$.

Users always switch to another that offers them a higher utility. But there is a marginal preference at point x_A for users of *A*, where it is indifferent between choosing *A* and switching to *B*, i.e.,

$$k\theta_A e_A - \alpha_A - bx_A + c_s = k\theta_B e_B - \alpha_B - b(1 - x_A)$$

Similarly, the point x_B where it is indifferent for users of *B* between keeping loyal or switching to *A* satisfies this condition

$$k\theta_B e_B - \alpha_B - b(1 - x_B) = k\theta_A e_A - \alpha_A - bx_B$$

Furthermore, we obtain the indifferent points

$$x_A = \left[(\alpha_B - \alpha_A) + k(\theta_A e_A - \theta_B e_B) + c_s + b\right] / (2b),$$

$$x_B = \left[(\alpha_B - \alpha_A) + k(\theta_A e_A - \theta_B e_B) + b\right] / (2b).$$

Thus, for all the users of the market, the users' proportion on *A* at equilibrium is

$x^* = (1-u-v)s_A + vx_B + u[s_A x_A + (1-s_A)x_B]$, where s_A represents the market share of leader *A*. Inserting x_A and x_B into it, we have

$$x^* = [1 - (1 - \frac{c_s}{2b})u - v]s_A + \frac{(u+v)}{2b}\left[(\alpha_B - \alpha_A) + k(\theta_A e_A - \theta_B e_B) + b\right]$$

We assume that the investment cost is $c(\theta, e) = k_1 e^2 / \theta$, which is a common assumption [18]. Thus, the platform's profits are

$$\pi_A = x^* \alpha_A - k_1 e_A{}^2 / \theta_A \quad \text{and} \quad \pi_B = (1 - x^*)\alpha_B - k_1 e_B{}^2 / \theta_B .$$

2.2 Optimization

In the E-commerce environment, the third party can easily observe the change of the disloyal users' proportion; correspondingly, the users can also estimate their profits. Thus, it's reasonable to assume that the game has complete information. Specifically, the time sequence of this game is as follows:

Period 1: the leader *A* first decides the investment level; and then the follower *B* decides its investment level;

Period 2: the two firms determine their prices simultaneously.

By solving the first-order conditions, we can find the equilibrium prices as follows

$$\alpha_A^* = \frac{2b}{3(u+v)}[1+(1-\frac{2b-c_s}{2b}u-v)s_A] + [k(\theta_A e_A - \theta_B e_B)+b]/3$$

$$\alpha_B^* = \frac{2b}{3(u+v)}[2-(1-\frac{2b-c_s}{2b}u-v)s_A] - [k(\theta_A e_A - \theta_B e_B)+b]/3$$

Inserting them into the profit functions, we have

$$\pi_A(e_A,e_B)=\frac{2b}{9(u+v)}\{1+(1-\frac{2b-c_s}{2b}u-v)s_A+\frac{u+v}{2b}[k(\theta_A e_A-\theta_B e_B)+b]\}^2-k_1(e_A)^2/\theta_A$$

$$\pi_B(e_A,e_B)=\frac{2b}{9(u+v)}\{2-(1-\frac{2b-c_s}{2b}u-v)s_A-\frac{u+v}{2b}[k(\theta_A e_A-\theta_B e_B)+b]\}^2-k_1(e_B)^2/\theta_B$$

Furthermore, solving the first-order conditions $\partial\pi_i(e_A,e_B)/\partial e_i=0$, *i=A, B*, we have

$$e_A^* = 2b\theta_A^2 J/(k\theta_B^3)$$

$$e_B^* = \frac{2kb\theta_B^2\{2-[1-v-u(2b-c_s)/(2b)]s_A-(u+v)/2-\theta_A^3(u+v)J/\theta_B^3\}}{[18k_1 b-k\theta_B^3(u+v)]}$$

where $J=\frac{1+(1-\frac{2b-c_s}{2b}u-v)s_A+\frac{(u+v)}{2}-\frac{k^2\theta_B^3}{6k_1 b}(u+v)}{\frac{k^2\theta_B^3}{18k_1 b}(u+v)^2-(2+\frac{\theta_A^3}{\theta_B^3})(u+v)+\frac{18k_1 b}{k^2\theta_B^3}}$.

3 Numerical examples

3.1 Sensitivity Analysis

In this section, we study the sensitivity analysis of equilibrium outcome in *u*, and how it is influenced by the parameter and the other main parameters, so we can investigate how to adjust the investment decisions in a dynamic environment.

Since the analytical equilibrium solutions are very complex, we just give some numerical computations and graphics.

For simplicity, we set the default values of parameters as: $k=1$, $b=1$, $c_s=0.5$, $k_1=0.05$, $\theta_A=0.4$, $\theta_B=0.8$, $s_A=0.6$ and $v=0.1$.

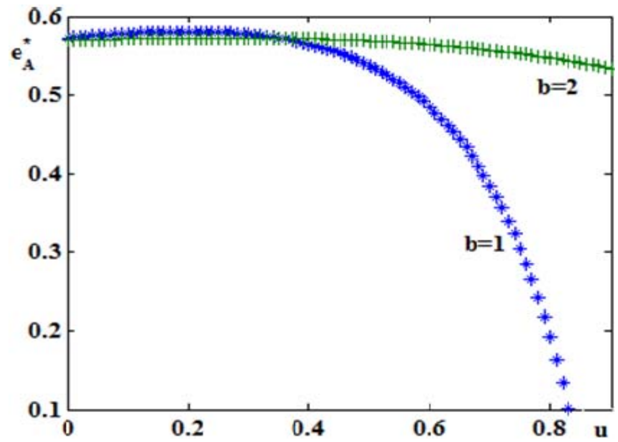

Figure 1. Optimal investment of *A* versus u and *b*

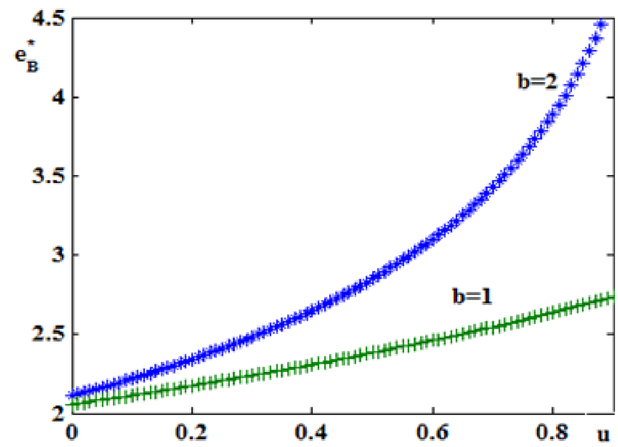

Figure 2. Optimal investment of *B* versus *u* and *b*

From Figures 1-8, we derive the following observations:

(i) Figures 1 and 2 show that *b* has an opposite effect on the optimal investments in two regions, respectively. That is, when the shopper's proportion *u* is low, e_A^* decreases but e_B^* increases with *b*; when *u* is high, e_A^* and e_B^* all increases with *b*. It can be explained as follows. If the proportion *u* is small, as the utility loss in preference increases, the users' preference is more distinguishing so that it is costly for leader *A* to invest and cannot attract more users. And if the shopper's number is

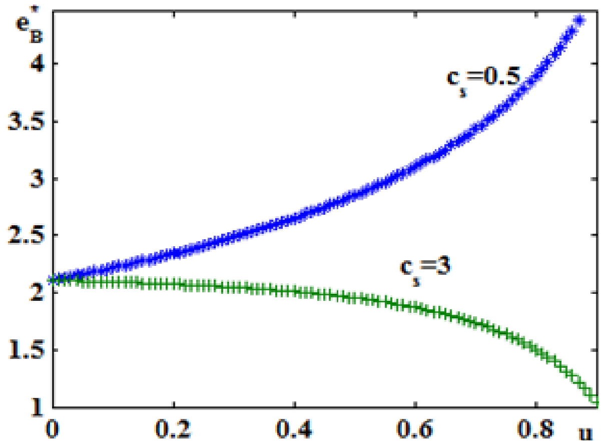

Figure 3. Optimal investment of *A* versus *u* and θ_A^B

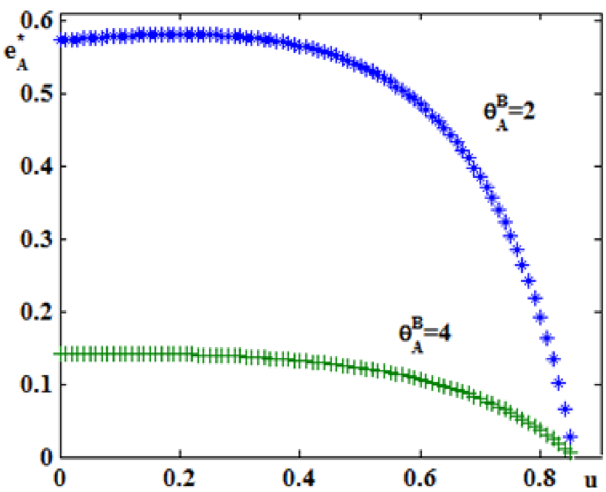

Figure 4. Optimal investment of *B* versus *u* and c_s

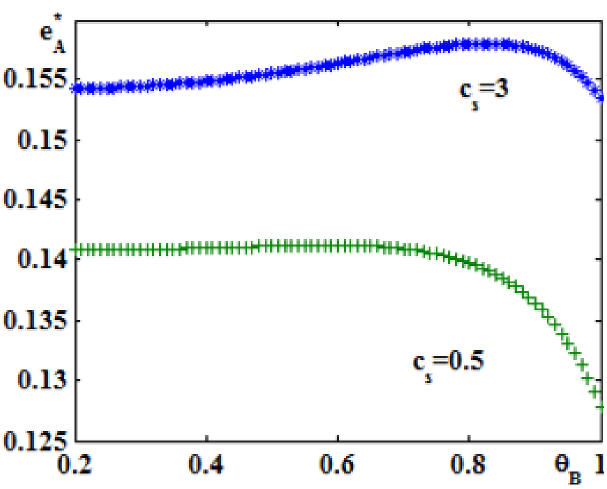

Figure 5. Optimal investment of *A* versus θ_B **and** c_s

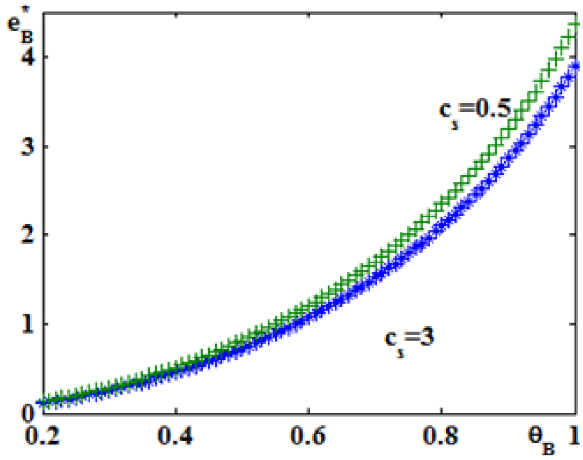

Figure 6. Optimal investment of *B* versus θ_B **and** c_s

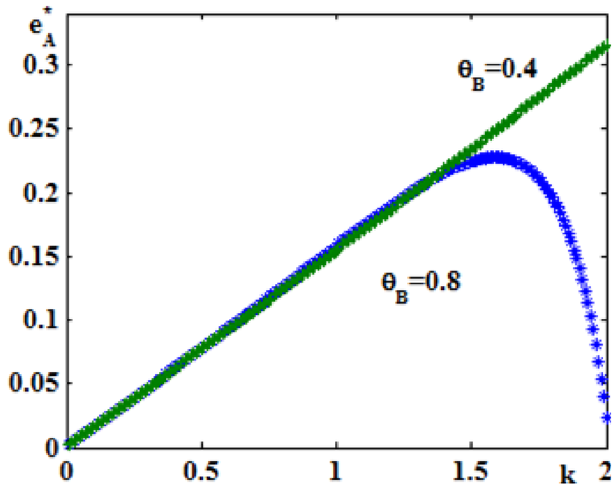

Figure 7. Optimal investment of *A* versus *k* and θ_B

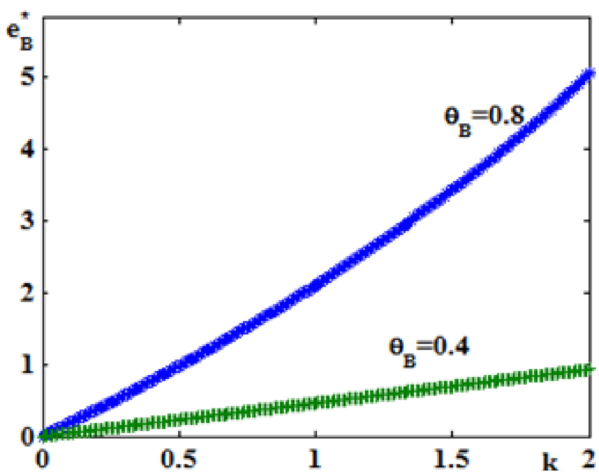

Figure 8. Optimal investment of *B* versus *k* and θ_B

large, with increasing of *b*, *A* has to make more investment to attract users. However, follower *B* always increases the investment because of the relative investment advantage.

(ii) Figures 1 and 4 imply that there often exists a threshold of the shoppers' proportion for *A* or *B* respectively, and if the shoppers' proportion is less than its threshold, the optimal investment of *A* or *B* increases with *u*; otherwise, it decreases with *u*. It suggests that there are two regions where the optimal investment changes with *u* in different monotone. Besides, Figures 3 and 4 imply that the extent of the regions depends on value of the parameters such as the switching cost c_s and the relative investment capability θ_A^B; that is, the threshold of *A* increases with the switching cost but decreases with the relative investment capability, while that of *B* has a opposite result.

(iii) According to Figures 5 and 6, the relative capability θ_A^B usually accelerates the increase of e_B^* while it prevents the increase of e_A^*, and the switching cost c_s has the contrary effect. Based on the Figures 3 and 4, we find that, when c_s is sufficiently low and θ_A^B is sufficiently high, with *u* increasing, the leader *A* decreases whereas the follower *B* increases their investment. In this condition, the behavior of follower *B* is aggressive. When c_s is sufficiently high and θ_A^B is sufficiently low, it is contrary to the above case (See Figure 4). When c_s and θ_A^B are all low, with *u* increasing, *A* decreases and *B* increases the investment, in which case the shopper's switching harms both *A* and *B* but *A* much than *B* because it's always worth for *B* to increase investment and he can attract more users. When c_s and θ_A^B are all sufficiently high, besides the profitability *k* is high enough, both e_A^* and e_B^* will increase with the proportion *u*. It suggests that the switching cost always makes it beneficial to leader *A*; while the high relative investment capability of *B* decreases its disadvantage and makes its behavior more aggressive.

(iv) According to Figures 7 and 8, we observe that the profitability *k* can increase not only the optimal investments of *A* and *B*, but also the impact of θ_A^B on the optimal investment. Especially, if k and θ_A^B are sufficiently large, the difference between the equilibrium outcome would be large. This result implies that, the market profitability not only intensifies the competition, but also increases the relative investment advantage of *B*. Specifically, in the case of *k* is sufficiently large, when the relative investment capability of *B* is high, the equilibrium outcome will be balanced or even *B* may own a comparative advantage and its behavior is aggressive; while in other cases, even though θ_A^B is large, it is difficult for *B* to behave aggressively and *A* is still a leader.

3.2 Managerial Implications

Now, we discuss the managerial implications. Given the users' preferences, the user disloyalty heterogeneity has a certain effect on the investment decisions in switching barrier. Moreover, the disloyal users' proportion usually changes with the investment decisions of the platforms. Consequently, the investment decisions should be continuously adjusted based on the change of disloyal users' proportion. Besides, since the impact is always influenced by the parameters such as the switching cost, the relative investment capability and the market profitability, the adjustments need taking the parameters into consideration.

We find that the investment in switching barrier can raise the user retention and lead to the proportions tending to a balanced distribution, so the competition can be relaxed. However, the switching cost and the relative investment capability always affect the equilibrium outcome, so the investment of the duopoly will be different. In summation, the user loyalty heterogeneity is beneficial to the superior who has the investment advantage in a profitable market. Furthermore, the higher the market profitability is, the larger the difference of the investment in switching barrier.

4 Conclusions

From the user loyalty heterogeneity perspective, we developed a users' switching model to study the impact of the user loyalty heterogeneity on the investment decisions of the platforms and its impact on the equilibrium outcome. In addition, we studied how to adjust the investment decisions based on the change of disloyal users' proportion when the economic environment changes.

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We find that the adjustments need to take the parameters such as the switching cost, the relative investment capability and the market profitability into consideration. There exist thresholds for the platforms, where it is indifferent for the users to switch, but the thresholds are influenced by the parameters.

We also find that the switching cost always makes it beneficial to leader *A*, while the high relative investment capability of *B* decreases its disadvantage and makes its behavior more aggressive. In addition, the user loyalty heterogeneity is beneficial to the superior who has the investment advantage in a profitable market, even though the investment in switching barrier can relax the competition, high market profitability not only intensifies the competition, but also increases the relative investment advantage, in this case follower *B* may own a comparative advantage and its behavior is aggressive.

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