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The Sequential Platform Competition in the Two-sided Market with Cases from the E-payment Industryzz*

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Abstract. In this paper, the authors analyzed the Two-sided Market theory applied in the e-payment industry with a geminate Salop Model, and considered that a detail classification of quasi-platform is needed. Then the authors explained typical cases according the model analyzing results.

Keywords: Two-sided Market, e-payment, Salop model, platform competition

1. Introduction

In the framework of Two-sided Market, the e-payment industry is a typical and even the most complex one. While the Two-sided Market defines two different types of users matching and trading through a certain midst channel, which is called the platform; and the midst platform needs to get both sides on board, considering cross-network externalities. The e-payment industry will utilize the electronic ways to process payment instructions issued by one side of users, typically the buyer; and acquired by the other side of users, typically the seller. And the electronic ways that the users can implement vary, such as bank cards, RFID, fingerprints.

Baxter (1983) models a four-party open network consisting of consumers, merchants, and their respective banks, and finds that to balance the demands for payment services by consumers and merchants, an interchange fee may be required to compensate the financial institution that serves the group that benefits less and/or faces higher costs to bring that group on board. Rochet and Tirole (2006) identifies Two-sided Markets with markets in which the structure, and not only the level of prices charged by platforms matters. Hagiu (2004) provides three explanations for the striking differences in platform pricing structures observed across these Two-sided Market industries. Evans (2002) considers Two-sided Market ranging from match makers to payment system (cash, cheque, cards, and emerging e-pay systems), and analyzed the ATM network's different pricing strategy for debit card, while credit card system will charge a higher interchange fee. It is considered that this paper has a deep through research for the classical e-payment industry based on Baxter (1983). Guthrie and Wright (2003) considers single-homing will not result in a lower interchange fee for the payment network, while the multi-homing will lead to a lower interchange fee for the merchants' monopolization, and if merchants' side compete for customers' side, the merchants have got more willingness to pay higher interchange fees. All these literatures conclude the role played by the platform, either in perfect competition or monopoly, but the focus in e-payment industry is still not enough. In this paper, the authors applied the sequential Salop model to analyze the platform competition in the e-payment industry, and illustrated the corresponding cases for the brief results from the model analysis.

2. The Sequential Salop Model

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Throughout the payment industry, such as for the card based payment system, exists two different market users -- merchants and cardholders (Rochet and Tirole 2003). And as is known, the payment process will be completed by a platform, such as the bank net or other processing institutions. From the perspective of Two-sided Market, the customer is harder to please, the more users on the platform, the more attractive the platform is; all the platform could do is to adjust the users' surplus of both sides and to make a trade-off in order to maximize the trade volume (Tang, *et.al*, 2008). So the users' utility function will be quite different from the traditional supply chain. Armstrong (2006) proposed the function as $u_j^i = a_j^i n^i + \varsigma_j^i$, where n^i is the number of users from the other side named i who are present on the platform, a_j^i is the benefit that user in side j enjoys from each user on side i, ς_j^i is the fixed benefit the user in side j obtains from using that platform. Generally speaking, all these variables are constant once the platform user chooses a certain side to on board, together with the platform itself has cultivated its market share since the market power can not change rapidly.

The e-payment industry, as a typical Two-sided Market, provides various payment solution for both the customers and the merchants; while different techniques are implemented to facilitate the payment procedures. And in this industry, the rapid change of techniques and different user interface make the value of a_j^i and ς_j^i change from stages to stages, while different platform provides different values as well. So we propose a sequential Salop model to solve the competition problems in two-sided market, which mainly focus on the e-payment industry.

Considering the uniqueness of e-payment industry, the buyers (denoted as side B) always have the power to choose the settlement channel, while the merchants (denoted as side S) have to accept it, the authors treat the side S as consistent, while heterogeneous in side B (described as Salop Model).

Suppose the market side for sellers as a circular city with the radius of 1 and the perimeter of 2π, let the whole market scale in the seller side is M, and the total e-payment service platform with a constant scale of n. Now for analytical continence, we set this circular market be under the complete and perfect coverage of the platform $\{i\}$, that is all the sellers should connect to a certain platform solely, and no market segment will out of the reach of platform i, and no seller will under the service of platform i and $i+1$ simultaneously ; what's more, we let no platform could service a faraway market segment belongs to platform $i+\varepsilon$ while beyond its close nearby platforms $i \pm 1$. We consider the pricing level of platform i is $p_i^{S,2t+1}$ for stages noted as $2t+1$, and the corresponding cost is $c_i^{S,2t+1}$.

And we can refine the location assumption in Figure 1 as follows. And considering for the seller, the e-payment action is proposed by the buyer as an essential part to complete the trade. This passiveness will lead to the seller distributed in this circular city decide whether to join the platform i in stage $2t+1$ mainly take the platform i's information about its buyer user base x_i^{2t} in previous stage $2t$ in to consideration, as well as the current pricing strategy $p_i^{S,2t+1}$ for the seller market. To introduce the dynamic analysis to simulate the evolutionary process, we set that the platform's installed user based in the buyer side for the previous stage will affect the location for the platform in the current stage, which means the seller will observer the platform's information correctly and timely, described as $n_{i+1}^{2t+1} = 2x_i^{2t} - n_i^{2t+1}$, and let $n_1^{2t+1} = 0$. And in the circular city, $i = n+1 \Leftrightarrow i = 1$.

Considering the cross network externality and the fundamental platform utility, the seller's utility function is: $u_i^{S,2t+1} = \omega_i^{2t+1} n_i^{B,2t} + \xi_i^{S,2t+1}$.

And we suggest that the complete and perfect coverage of the market, so the marginal seller's positioning problem is easy to solve: $u_i^{S,2t+1} - \tau(\hat{x}_i^{2t+1} - n_i^{2t+1}) - p_i^{S,2t+1} = u_{i+1}^{S,2t+1} - \tau(n_{i+1}^{2t+1} - \hat{x}_i^{2t+1}) - p_{i+1}^{S,2t+1}$

So it will induce the indifference seller between the platform i and platform $i+1$ in stage $2t+1$:

$$\hat{x}_i^{2t+1} = \frac{1}{2\tau}\left(u_i^{S,2t+1} - u_{i+1}^{S,2t+1} + \tau(n_i^{2t+1} + n_{i+1}^{2t+1}) + p_{i+1}^{S,2t+1} - p_i^{S,2t+1}\right) = x_i^{2t} + \frac{u_i^{S,2t+1} - u_{i+1}^{S,2t+1}}{2\tau} + \frac{p_{i+1}^{S,2t+1} - p_i^{S,2t+1}}{2\tau}$$

And the market share for platform i in the seller side for stage $2t+1$ is $D_i^{S,2t+1} = \frac{M}{2\pi}(x_i^{2t} - x_{i-1}^{2t})$, and its profit function will be $\prod_i^{S,2t+1} = \frac{M}{2\pi}(p_i^{S,2t+1} - c_i^{S,2t+1})(x_i^{2t} - x_{i-1}^{2t})$.

Then we will focus on the buyer side of the platform $\{i\}$, almost the same assumption for the circular city with a radius of 1 and the perimeter of 2π, let the whole market scale in the buyer side is N, and the total e-payment service platform with a constant scale of n. Now for analytical continence, we set this circular market be under the complete and perfect coverage of the platform $\{i\}$, that is all the buyers should connect to a certain platform solely, and no market segment will out of the reach of platform i, and no buyer will under the service of platform i and $i+1$ simultaneously; what's more, we let no platform could service a faraway market segment belongs to platform $i+\varepsilon$ while beyond its close nearby platforms $i\pm1$. We consider the pricing level of platform i is $p_i^{B,2t}$ for stages noted as $2t$, and the corresponding cost is $c_i^{B,2t}$.

And we can refine the location assumption in Figure 2 as follows. And considering for the buyer, the e-payment action is proposed by the buyer as an essential part to complete the trade. This initiative will lead to the buyer distributed in this circular city decide whether to join the platform i in stage $2t$ mainly take the platform i's information about its seller user base x_i^{2t-1} in previous stage $2t-1$ in to consideration, as well as the current pricing strategy $p_i^{B,2t}$ for the buyer market. To introduce the dynamic analysis to simulate the evolutionary process, we set that the platform's installed user based in the buyer side for the previous stage will affect the location for the platform in the current stage, which means the seller will observer the platform's information correctly and timely, described as $n_{i+1}^{2t} = 2x_i^{2t-1} - n_i^{2t}$, and let $n_1^{2t} = 0$. And in the circular city, $i = n+1 \Leftrightarrow i = 1$.

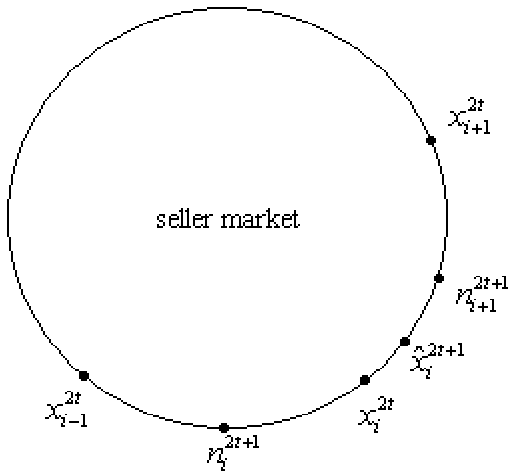

Figure 1: Circular city in seller market

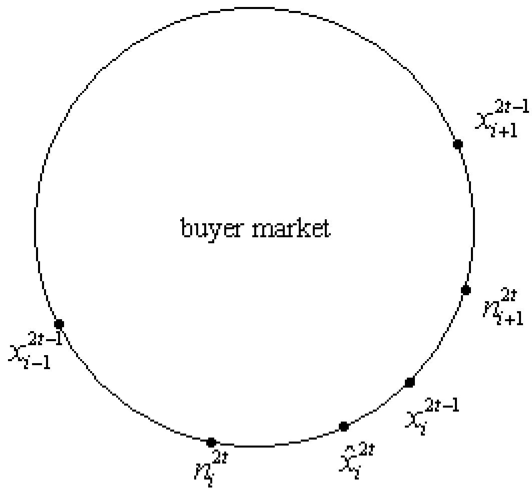

Figure 2: Circular city in buyer market

Considering the cross network externality and the fundamental platform utility, the buyer's utility function is: $u_i^{B,2t} = \omega_i^{2t} n_i^{S,2t-1} + \xi_i^{B,2t}$.

And we suggest that the complete and perfect coverage of the market, so the marginal buyer's positioning problem is easy to solve: $u_i^{B,2t} - \upsilon(\hat{x}_i^{2t} - n_i^{2t-1}) - p_i^{B,2t} = u_{i+1}^{B,2t} - \upsilon(n_{i+1}^{2t-1} - \hat{x}_i^{2t}) - p_{i+1}^{B,2t}$

So it will induce the indifference buyer between the platform i and platform $i+1$ in stage $2t$:

$$\hat{x}_i^{2t} = \frac{1}{2\upsilon}\left(u_i^{B,2t} - u_{i+1}^{B,2t} + \upsilon(n_i^{2t-1} + n_{i+1}^{2t-1}) + p_{i+1}^{B,2t} - p_i^{B,2t}\right) = x_i^{2t-1} + \frac{u_i^{B,2t} - u_{i+1}^{B,2t}}{2\upsilon} + \frac{p_{i+1}^{B,2t} - p_i^{B,2t}}{2\upsilon}$$

And the market share for platform i in the buyer side for stage $2t$ is $D_i^{B,2t} = \frac{N}{2\pi}(x_i^{2t-1} - x_{i-1}^{2t-1})$, and its profit function will be $\prod_i^{B,2t} = \frac{N}{2\pi}(p_i^{B,2t} - c_i^{B,2t})(x_i^{2t-1} - x_{i-1}^{2t-1})$.

In each geminate stage, we consider it in pair, so in stage pair t, the platform's market share information function is:

$$x_i^{2t} = x_i^{2t-2} + \frac{u_i^{B,2t} - u_{i+1}^{B,2t}}{2\upsilon} + \frac{p_{i+1}^{B,2t} - p_i^{B,2t}}{2\upsilon} + \frac{u_i^{S,2t-1} - u_{i+1}^{S,2t-1}}{2\tau} + \frac{p_{i+1}^{S,2t-1} - p_i^{S,2t-1}}{2\tau}$$

$$= x_i^0 + \frac{1}{2\upsilon}\sum_{\varphi=0}^{t}\Big((u_i^{B,2\varphi} - u_{i+1}^{B,2\varphi}) + (p_{i+1}^{B,2\varphi} - p_i^{B,2\varphi})\Big) + \frac{1}{2\tau}\sum_{\varphi=0}^{t}\Big((u_i^{S,2\varphi-1} - u_{i+1}^{S,2\varphi-1}) + (p_{i+1}^{S,2\varphi-1} - p_i^{S,2\varphi-1})\Big)$$

The main profit function for platform i is:

$$\prod_i^t = \frac{M}{2\pi}(p_i^{S,2t-1} - c_i^{S,2t-1})\left(\begin{array}{l}\frac{2\pi}{n} + \frac{1}{2\upsilon}\sum_{\varphi=0}^{t-1}\Big((2u_i^{B,2\varphi} - u_{i-1}^{B,2\varphi} - u_{i+1}^{B,2\varphi}) + (p_{i+1}^{B,2\varphi} + p_{i-1}^{B,2\varphi} - 2p_i^{B,2\varphi})\Big) + \\ \frac{1}{2\tau}\sum_{\varphi=0}^{t-1}\Big((2u_i^{S,2\varphi-1} - u_{i-1}^{S,2\varphi-1} - u_{i+1}^{S,2\varphi-1}) + (p_{i+1}^{S,2\varphi-1} + p_{i-1}^{S,2\varphi-1} - 2p_i^{S,2\varphi-1})\Big)\end{array}\right)$$

$$+ \frac{N}{2\pi}(p_i^{B,2t} - c_i^{B,2t})\left(\begin{array}{l}\frac{2\pi}{n} + \frac{1}{2\upsilon}\sum_{\varphi=0}^{t}\Big((2u_i^{B,2\varphi} - u_{i-1}^{B,2\varphi} - u_{i+1}^{B,2\varphi}) + (p_{i+1}^{B,2\varphi} + p_{i-1}^{B,2\varphi} - 2p_i^{B,2\varphi})\Big) + \\ \frac{1}{2\tau}\sum_{\varphi=0}^{t}\Big((2u_i^{S,2\varphi-1} - u_{i-1}^{S,2\varphi-1} - u_{i+1}^{S,2\varphi-1}) + (p_{i+1}^{S,2\varphi-1} + p_{i-1}^{S,2\varphi-1} - 2p_i^{S,2\varphi-1})\Big)\end{array}\right)$$

Set the originality of this Salop model from stage $t = 0$, which means the platform will compete from a starting line. We suppose that the platform i will promote in the seller side first, with a certain but unknown installed user base in the buyer side. Since the lack of information about the platform, we suggest that the seller will treat different platforms as equal market power, that is $x_i^0 - x_{i-1}^0 = \frac{2\pi}{n}$.

Specially, the stage $t = 1$, the platform information is:

$$x_i^2 = \frac{1}{2\tau}\Big(u_i^{S,2} - u_{i+1}^{S,2} + 2\tau x_i^0 + p_{i+1}^{S,2} - p_i^{S,2}\Big) = x_i^0 + \frac{u_i^{S,2} - u_{i+1}^{S,2}}{2\tau} + \frac{p_{i+1}^{S,2} - p_i^{S,2}}{2\tau}.$$

And its main profit is: $\prod_i^1 = \frac{M}{n}(p_i^{S,1} - c_i^{S,1}) + \frac{N}{n}(p_i^{B,2t} - c_i^{B,2t})$.

3. Industrial Case Review

3.1. The innovation incentives

If the platform i wants to increase the market share and improve its attractiveness, despite the originality of installed user base, the solution might be increasing the utilities for either or both side of the users, and decreasing the pricing level for either or both side of the users. As is known that, if the platform i's pricing strategy set and the utility set for the platform users in different stages are decrescendo, there exists an exclusive equilibrium for every platform involved.

Since the assumption, that $\{u_i^{S,t}\}$, $\{u_i^{B,t}\}$, $\{p_i^{S,t}\}$ and $\{p_i^{B,t}\}$ are all Cauchy Sequence, which will lead to a fixed point solution, can not be treated as a usual thing with in the e-payment industry. The e-payment platform will have an incentive to improve new technologies in order to increase the utilities for the payment users (either the buyer or the seller, even both of them), which can be treated as a useful competition way instead of fierce pricing competition (Tang, et.al, 2009).

To accelerate the payment process, the bank and bank net invent the NFC payment (typically installed in mobiles and bank cards, which contain a RFID chip inside to exchange the account information with the POS terminals wirelessly). This will facilitate the small amount payments, especially the fast food restaurant and public transportation charging. But a demerit has been found that the paywave signals could be received unintentionally, and be cracked easily, which blocks its popularization. There exists a possibility that the paywave technology might be widely accepted for small amount and speed-pursuing applications only.

3.2. The pricing collusion

Considering $t \in [0, +\infty)$, suppose the platform i is not-for-profit, if $\prod = \sum_{0}^{+\infty} \prod_i^t = 0$, then the platform must charge both sides a package of prices to fully coverage its operational cost. But for most of the platforms whose are just for-profit, there is a way to reduce the worthless pricing competition, and the pricing collusion will lead to the maximal differentiation via positioning for all the participated platforms.

If all the platforms are under pricing collusion, and they proposed a policy of $p_\gamma^{S,t} - c_\gamma^{S,t} = S^{S,t}$ and $p_\gamma^{B,t} - c_\gamma^{B,t} = S^{B,t}$, we induce: $\prod^t = \sum_{\gamma=1}^{n} \prod_\gamma^t = \frac{MS^{S,t}}{2\pi} \sum_{\gamma=1}^{n} (x_\gamma^{2t-2} - x_{\gamma-1}^{2t-2}) + \frac{NS^{B,t}}{2\pi} \sum_{\gamma=1}^{n} (x_\gamma^{2t-1} - x_{\gamma-1}^{2t-1})$. To maximize the profit range of platform i, it will be intuitive friendly to find the positioning differentiation to avoid potential competition which will lead to additional profit lost, which is often observed in the e-payment industry.

Most of the online payment gateways do provide almost the same solutions for small or medium size websites, who need to provide online cashing service but do not have enough negotiation capabilities with large financial institutions for more sound payment fee discounts. Some service providers, such as the PayEase and 99bill.com, who provide website payment solutions which seem greatly alike, and they usually charge the payment fee in a ratio between 1%-1.5%, which is a bit higher than the actual payment fee (usually 0.1%-0.9%, expect for the hotels and the resorts with a ratio higher than 2%) with credit cards or debit cards. We have noticed that the online payment fee do not decrease to the general level, which means a pricing collusion has taken place within this industry, since the additional cost for the online payment might be quite small.

4. Conclusion

In the current paper, we analyzed the two-sided platform competition based on some practical cases from the e-payment industry, and with a sequential Salop model, we could describe the competition strategies for the two-sided platform to reduce the unnecessary direct competition through innovation to increase the utilities of payment users, while maintain a relative stabilized market share through pricing collusion.

5. References

[1] Armstrong, M. (2006). “Competition in two-sided markets”. Rand Journal of Economics 37(3): 668-691.

[2] Baxter, W. F. (1983). “Bank Interchange of Transactional Paper: Legal and Economic Perspectives”, *Journal of Law & Economics*, 26(3): 48.

[3] Evans, D. S. (2002). “The Antitrust Economics of Two-sided Markets”, *AEI-Brookings Joint Center for Regulatory Studies*: 76.

[4] Guthrie, G. and Wright J. (2007). “Competing payment schemes” *Journal of Industrial Economics*, 55(1): 37-67.

[5] Hagiu, A. (2004). “Two-Sided Platforms: Pricing and Social Efficiency”, *Working paper (No. 04035)*, Research Institute of Economy, Trade and Industry.

[6] Hagiu, A. (2008). “Two-Sided Platforms: Product Variety And Pricing Structures”, *Working paper*: 35.

[7] Rochet, J. C. and Tirole, J. (2003). “Platform Competition in Two-sided Markets”, *European Economic Association*: 41.

[8] Rochet, J. C. and Tirole, J. (2006). “Two-sided markets: a progress report”, *Rand Journal of Economics*, 37(3): 645-667.

[9] Tang, W.J., Chen, H.M. and Xu, L. (2008). “Adjustment and trade-off: the business model for two-sided platforms”, *Performance*, 1(4).

[10] Tang, W.J., Chen, H.M. and Xu, L. (2009). “The agent in two-sided market a study of e-payment industry”, *The Proceedings of 2009 International Conference on Computer Engineering and Technology. ICCET 2009* , vol. 2: 166-70; ICCET 2009, Singapore, 22-24 Jan. 2009.