Price Competition Strategy of Internet platforms

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Abstract

The papergeneralizes the economic features about Internet platforms and analyzestheir competitive strategies with the method of insulating pricing.The analysis focuses onthe quantity expectations game of platformsand their price expectations game.The function ofnetwork externalities on the Internet platforms hasan obvious feature of two stages, sotheircompetitive strategieshave to be divided into two distinct phases. Before the critical mass stage, companies need to pursue a rapid increase of subscribers in order to survive. After the critical capacity, differentiation strategy can be implemented by platform companies which seek maximum profit by the action of network externalities.

Keywords: Internet platform,insulating pricing, non-cooperative game,Competitive Strategy

Introduction

In the Internet era of big data, various Internet platforms stake to fierce competition, which leads to a problem about how the Internet platforms compete. Compared with the traditional competitive strategies, competitive strategy of Internet platforms hides the key factor to success. This article attempts to explain competitive strategy of Internet platforms from a perspective of the network economic, which provides theoretical support and practical guidance for competition on the Internet platforms.

Internet platformsarethe product of network economic development, so they have a lot of different characteristics compared with traditional companies. First, Platforms have significant network externalities (Katzand Shapiro, 1985), which are generally divided into membership and usage externalities (Rochet andTirole, 2003; Armstrong, 2006).In addition to the analysis of network effects of platforms(Economides, 1995), moreLiteratures discuss pricing strategy of platformsfrom membership externalities (Armstrong, 2006) and usageexternalities(Rochet and Tirole, 2006). Weyl (2010) analyzed optimal pricing of platforms under different target with the method of insulatingtariffs. A more realistic problem is how platforms to participate in the competition. So the paper

mainly analyzes the competitive strategies of Internet platformsthrough two-sided markets and game theory.

The paper is structured as follows.Section1introduces the basic features and model assumptions of the Internet platforms. Section 2 constructs theoretical models of platforms competition, includes the dynamic model about users' scale expectations and price expectations. Section 3summarizes the full paper and makes some relevant suggestions

Theoretical Model

In order to analyze competitive strategiesof platforms more clearly, the paper gives some assumptions:

(1) This analysisfocus on two platforms (i , j). When an Internet platform makes decisions, the other platforms are considered as a whole by it, namely two platforms inthe market. Platforms have two sides, d side and s side.

(2) Only considering cross externalities of platforms, without considering externalities in the same side of platforms. Because the role of network makes marginal cost providing services to users is closely to zero.

Dynamic Game Model of quantity expectations

First, weanalyze how bilateral platforms takeprice competition with the methods of insulating tariffs and Game of expectation about users'quantity or scale (as amended Cournot model). Internet platforms have cross network externalities. The price of one side by platform charged is based on the (expected) quantity of users on the other size. Therefore, the pricing function of competitive platforms is:

$$\begin{cases} p_i^d(n_i^s) = \alpha_i^d n_i^s + h_i n_j^{de} \\ p_i^s(n_i^d) = \alpha_i^a n_i^d + h_i n_j^{se} \end{cases} \quad \begin{cases} p_j^d(n_j^s) = \alpha_j^d n_j^s + h_j n_i^{de} \\ p_j^s(n_j^d) = \alpha_j^s n_j^d + h_j n_i^{se} \end{cases} \quad (1)$$

Where, $h_i n_j^{de}$ is competitors' market share of a platform, h_i is adjustment factor which can be either positive or negative, but it is usually negative in the model about expected quantity. It means that price of platform charged and userscale of the other side is negatively correlated.

Profit function of platforms can be transformed into:

$$\begin{cases} \pi_i = (\alpha_i^d n_i^s + h_i n_j^{de} - c_i^d)n_i^d + (\alpha_i^s n_i^d + h_i n_j^{se} - c_i^s)n_i^s - C_i \\ \pi_j = (\alpha_j^d n_j^s + h_j n_i^{de} - c_j^d)n_j^d + (\alpha_j^s n_j^d + h_j n_i^{se} - c_j^s)n_j^s - C_j \end{cases} \quad (2)$$

Proposition 1: In the game about expectedquantity, the price ofone side set by platforms is determinedby cross network externalitiesand expected adjustment of competitors' market scale. Final equilibrium results are:

$$
\begin{cases}
n_i^d = \dfrac{c_i^s - h_i\, n_j^{se}}{\alpha_i^d + \alpha_i^s} \\[2ex]
n_i^s = \dfrac{c_i^d - h_i\, n_j^{de}}{\alpha_i^d + \alpha_i^s} \\[2ex]
n_j^d = \dfrac{c_j^s - h_j\, n_i^{se}}{\alpha_j^d + \alpha_j^s} \\[2ex]
n_j^s = \dfrac{c_j^d - h_j\, n_i^{de}}{\alpha_j^d + \alpha_j^s}
\end{cases}
;
\begin{cases}
p_i^d = \dfrac{\alpha_i^d c_i^d + \alpha_i^s h_i\, n_j^{de}}{\alpha_i^d + \alpha_i^s} \\[2ex]
p_i^s = \dfrac{\alpha_i^s c_i^s + \alpha_i^d h_i\, n_j^{se}}{\alpha_i^d + \alpha_i^s} \\[2ex]
p_j^d = \dfrac{\alpha_j^d c_j^d + \alpha_j^s h_j\, n_i^{de}}{\alpha_j^d + \alpha_j^s} \\[2ex]
p_j^s = \dfrac{\alpha_j^s c_j^s + \alpha_j^d h_j\, n_i^{se}}{\alpha_j^d + \alpha_j^s}
\end{cases}
\tag{3}
$$

From the result, the users' scale of one side onthe platform is decided by marginal cost of providing theses service, target users' scale of competitors and cross network externalities. The price of one side on the platform is depended on cross network externalities, the expected share of competitors and marginalcost.

Then we analyze the impact of each factor on the platform pricing using the method of control variables:

(1)Marginal cost. Assume that cross network externalities coefficient and the expected scale of competitorsare constant, the price function is:

$$
p_i^d = \frac{\overline{\alpha_i^d}\,\overline{c_i^d} + \overline{\alpha_i^s}\,\overline{h_i\, n_j^{de}}}{\overline{\alpha_i^d} + \overline{\alpha_i^s}}
$$

It means that theprice set byplatforms is a positive correlation withthe marginal cost of platforms' services. This is consistent with the law of economics that the higher cost of these services provided for each customer interaction, the higher price charged by platforms.

(2)Expected scale ofcompetitors' other users. Assume that cross network externalities coefficient andmarginal cost are constant, the price function is:

$$
p_i^d = \frac{\overline{\alpha_i^d}\,\overline{c_i^d} + \overline{\alpha_i^s}\, h_i\, n_j^{de}}{\overline{\alpha_i^d} + \overline{\alpha_i^s}}, \text{ (where } h_i < 0)
$$

It means that theprice set by platforms is anegative correlation with the expected scale of users on the other side of other competing platforms. This is consistent with the law of economics that the moreexpected scale of users on the other side of other competing platforms, the lower price charged by platforms.

(3)Cross network externalities coefficient.Assume that the expected scale of competitors and marginal costare constant, the price function is:

$$p_i^d = \frac{\alpha_i^d \overline{c_i^d} + \alpha_i^s \overline{h_i n_j^{de}}}{\alpha_i^d + \alpha_i^s} \quad \text{(where } h_i < 0\text{)}$$

When $c_i^d > h_i n_j^{de}$, cross network externalities coefficient α_i^d is a positive correlationwith the price charged by platforms, cross network externalities coefficient α_i^s isa negative correlation with the price charged by platforms. When $c_i^d < h_i n_j^{de}$, cross network externalities coefficient α_i^d is a negative correlation with the price charged by platforms, cross network externalities coefficient α_i^s is a positive correlationwith the price charged by platforms.

When the scale of platforms excess critical capacity, marginal cost of the service provided by platforms is close to zero, $c_i^d = 0$. Then $p_i^d = \frac{\alpha_i^s \overline{h_i n_j^{de}}}{\alpha_i^d + \alpha_i^s}$ which means that the price is mainly influenced by cross network externalities coefficient. When the scale ofone side on the platform i increases gradually and makes $c_i^d = h_i n_j^{de}$, the competition of platforms can reach an equilibrium finally.

Afterthe scale of users exceeds critical capacity, platforms can pricing for service based on the size of externalities, and then enter the competitive differentiation stage.

Corollary 1: In repeated games, the equilibrium prices for Internet platforms are:

$$\begin{cases} p_i^d = \dfrac{\alpha_i^d c_i^d (\alpha_j^d + \alpha_j^s) + \alpha_i^s h_i c_j^s - h_i h_j c_i^d}{(\alpha_i^d + \alpha_i^s)(\alpha_j^d + \alpha_j^s) - h_i h_j} \\[2mm] p_i^s = \dfrac{\alpha_i^s c_i^s (\alpha_j^d + \alpha_j^s) + \alpha_i^d h_i c_j^d - h_i h_j c_i^s}{(\alpha_i^d + \alpha_i^s)(\alpha_j^d + \alpha_j^s) - h_i h_j} \\[2mm] p_j^d = \dfrac{\alpha_j^d c_j^d (\alpha_i^d + \alpha_i^s) + \alpha_j^s h_j c_i^s - h_i h_j c_j^d}{(\alpha_i^d + \alpha_i^s)(\alpha_j^d + \alpha_j^s) - h_i h_j} \\[2mm] p_j^s = \dfrac{\alpha_j^s c_j^s (\alpha_i^d + \alpha_i^s) + \alpha_j^d h_j c_i^d - h_i h_j c_j^s}{(\alpha_i^d + \alpha_i^s)(\alpha_j^d + \alpha_j^s) - h_i h_j} \end{cases} \quad (4)$$

In thequantity games, the competing platforms can reach an equilibrium state, which each platform will pricing based on the coefficient of interactive value.

In order to simplify the analysis, the interaction coefficient and costs of the same platform

does not distinguish, namely $\alpha_i^d = \alpha_i^s = \alpha_i$, $\alpha_j^d = \alpha_j^s = \alpha_j$, $c_i^d = c_i^s = c_i$,

$c_j^d = c_j^s = c_j$ .Thus price function can be simplified as:

$$p_i = \frac{2\alpha_i c_i \overline{\alpha_j} + \alpha_i h_i \overline{c_j} - h_i \overline{h_j} c_i}{4\alpha_i \overline{\alpha_j} - h_i \overline{h_j}} \tag{5}$$

The price on the side set byplatforms depends on the interaction coefficient, marginal cost factor and the expected users' share of opponents.

Partial derivative on the price factor, as follows:

$$\begin{cases} \dfrac{\partial p_i}{\partial \alpha_i} = \dfrac{(2\overline{\alpha_j} c_i - h_i \overline{c_j})h_i \overline{h_j}}{(4\alpha_i \overline{\alpha_j} - h_i \overline{h_j})^2} \\[3mm] \dfrac{\partial p_i}{\partial c_i} = \dfrac{2\alpha_i \overline{\alpha_j} - h_i \overline{h_j}}{(4\alpha_i \overline{\alpha_j} - h_i \overline{h_j})} \\[3mm] \dfrac{\partial p_i}{\partial h_i} = \dfrac{2\alpha_i \overline{\alpha_j}(2\alpha_i \overline{c_j} - c_i \overline{h_j})}{(4\alpha_i \overline{\alpha_j} - h_i \overline{h_j})^2} \end{cases} \tag{6}$$

(1)Expected scale of competitors.When $\alpha_i > \dfrac{c_i}{2}$, $\dfrac{\partial p_i}{\partial h_i} > 0$, namely the price and

expected share are a positive correlation. When $\alpha_i < \dfrac{c_i}{2}$, $\dfrac{\partial p_i}{\partial h_i} < 0$, namely the price

and expected share are a negative correlation.

(2)Cross network externalities coefficient. When $c_i^d > h_i$, $\dfrac{\partial p_i}{\partial \alpha_i} > 0$, namely the price

and cross network externalities coefficient are a positive correlation. When $c_i^d < h_i$,

$\dfrac{\partial p_i}{\partial \alpha_i} < 0$, namely the price and cross network externalities coefficient are a negative

correlation.

These results further provethe existence and impact of critical mass in the platforms

network. When $\alpha_i = \dfrac{c_i}{2}$, the platforms network reaches a critical mass.

Dynamic Game Model of price expectations

The paperanalyzescompetitive behavior of Internet platformsfromthe angle of expected quantitygames strategy previously. However,it is difficult to observe user scale of competitors in reality when platforms makespecific decisions. So people concernmore about competitors' recent price strategy.Thenthe paperfurther analyzes competitive behavior of Internet platformsfrom the angle of expected price games strategy. According toadaptive expectations in economics (time nearly effects of business or personal decisions), weamend competitionmodel of platformswith joining the recent price adjustment factor.

Assuming price adjustment factor of platforms is influenced by the price of competitors in the previous period. The pricingfunction of platforms is:

$$
\begin{cases}
p_{it}^d(n_{it}^s, p_{j(t-1)}^d) = \alpha_i^d n_{it}^s + h_i^d p_{j(t-1)}^d \\
p_{it}^s(n_{it}^d, p_{j(t-1)}^s) = \alpha_i^s n_{it}^d + h_i^s p_{j(t-1)}^s
\end{cases}
;
\begin{cases}
p_{jt}^d(n_{jt}^s, p_{i(t-1)}^d) = \alpha_j^d n_{jt}^s + h_j^d p_{i(t-1)}^d \\
p_{jt}^s(n_{jt}^d, p_{i(t-1)}^s) = \alpha_j^s n_{jt}^d + h_j^s p_{i(t-1)}^s
\end{cases}
\tag{7}
$$

Profit function of platforms can be transformed into:

$$
\begin{cases}
\pi_i = (\alpha_i^d n_{it}^s + h_i^d p_{j(t-1)}^d - c_i^d)n_{it}^d + (\alpha_i^s n_{it}^d + h_i^s p_{j(t-1)}^s - c_i^s)n_{it}^s - C_i \\
\pi_j = (\alpha_j^d n_{jt}^s + h_j^d p_{i(t-1)}^d - c_j^d)n_{jt}^d + (\alpha_j^s n_{jt}^d + h_j^s p_{i(t-1)}^s - c_j^s)n_{jt}^s - C_j
\end{cases}
\tag{8}
$$

Proposition2: In the game about expected price, the price ofone side set by platformsfor users is determinedby cross network externalities and expected adjustment of competitors' price. Final equilibrium results are :

$$
\begin{cases}
n_{it}^d = \dfrac{c_i^s - h_i^s p_{j(t-1)}^s}{\alpha_i^d + \alpha_i^s} \\[2mm]
n_{it}^s = \dfrac{c_i^d - h_i^d p_{j(t-1)}^d}{\alpha_i^d + \alpha_i^s} \\[2mm]
n_{jt}^d = \dfrac{c_j^s - h_j^s p_{i(t-1)}^s}{\alpha_j^d + \alpha_j^s} \\[2mm]
n_{jt}^s = \dfrac{c_j^d - h_j^d p_{i(t-1)}^d}{\alpha_j^d + \alpha_j^s}
\end{cases}
;
\begin{cases}
p_{it}^d = \dfrac{\alpha_i^d c_i^d + \alpha_i^s h_i^d p_{j(t-1)}^d}{\alpha_i^d + \alpha_i^s} \\[2mm]
p_{it}^s = \dfrac{\alpha_i^s c_i^s + \alpha_i^d h_i^s p_{j(t-1)}^s}{\alpha_i^d + \alpha_i^s} \\[2mm]
p_{jt}^d = \dfrac{\alpha_j^d c_j^d + \alpha_j^s h_j^d p_{i(t-1)}^d}{\alpha_j^d + \alpha_j^s} \\[2mm]
p_{jt}^s = \dfrac{\alpha_j^s c_j^s + \alpha_j^d h_j^s p_{i(t-1)}^s}{\alpha_j^d + \alpha_j^s}
\end{cases}
\tag{9}
$$

From these results, the users' scale of one side on the platform is decided by marginal cost

of providing theses service, priorprice set by competitors and cross network externalities.The price of one side on the platform is depended on cross network externalities, the expected price of competitors and marginal cost.

(1) Cross network externalities coefficient.Assume that the expected price of competitors and marginal costare constant, the price function is:

$$p_i^d = \frac{\alpha_i^d \overline{c_i^d} + \alpha_i^s \overline{h_i p_{j(t-1)}^d}}{\alpha_i^d + \alpha_i^s} \quad \text{(where } h_i > 0)$$

When ($\alpha_i^d \overline{c_i^d} + \alpha_i^s \overline{h_i p_{j(t-1)}^d}$)>($\alpha_i^d + \alpha_i^s$), the larger cross network externalities

coefficient, the lower the price set by platforms. When ($\alpha_i^d \overline{c_i^d} + \alpha_i^s \overline{h_i p_{j(t-1)}^d}$)<($\alpha_i^d + \alpha_i^s$),

the larger cross network externalities coefficient, the higher the price set by platforms.

(2) Marginal cost. Assume that cross network externalities coefficient and the expected price of competitors are constant, the price function is:

$$p_i^d = \frac{\overline{\alpha_i^d} c_i^d + \overline{\alpha_i^s h_i p_{j(t-1)}^d}}{\overline{\alpha_i^d} + \overline{\alpha_i^s}}$$

It means thatthe higher cost of these services provided for each customer interaction, the higher price charged by platforms.

(3)Expected price ofcompetitors. Assume that cross network externalities coefficient andmarginal cost are constant, the price function:

$$p_i^d = \frac{\overline{\alpha_i^d c_i^d} + \overline{\alpha_i^s} h_i p_{j(t-1)}^d}{\overline{\alpha_i^d} + \overline{\alpha_i^s}}, \text{(where } h_i > 0)$$

It means that theprice set by platforms is apositive correlation with the expected priceon the other side of competing platforms.

Also it is known that platforms can set a price on their service based on the size of externalities, and then enter the competitive differentiation stage, after critical capacity.

Corollary 2: In repeated games, the equilibrium price of Internet platforms is:

$$p_{it}^d = \frac{(\alpha_i^d c_i^d + \alpha_i^s h_i^d)\alpha_j^d c_j^d + (\alpha_j^d + \alpha_j^s)\alpha_i^d c_i^d}{(\alpha_i^d + \alpha_i^s)(\alpha_j^d + \alpha_j^s) - (\alpha_i^d c_i^d + \alpha_i^s h_i^d)\alpha_j^s h_j^d} \quad (10)$$

This paper analyzes the competitive strategies between the two platforms.In order to simplify the analysis, the interaction coefficient of the same platform does not distinguish, namely $\alpha_i^d = \alpha_i^s$, $\alpha_j^d = \alpha_j^s$. Thus the formula can be simplified to:

$$p_i = \frac{2(c_i + h_i)\alpha_i \alpha_j c_j + 2\alpha_j \alpha_i c_i}{4\alpha_i \alpha_j - 2(c_i + h_i)\alpha_i \alpha_j h_j} = \frac{(c_i + h_i)c_j + c_i}{2 - (c_i + h_i)h_j} \quad (11)$$

The price of the platforms is affected by the marginal cost and expected adjustment factor. According to adaptive expectations, the expected price is mainlyaffected bythe previous one, that is $h_i = h_j = 1$, the price function can be translated into:

$$p_i = \frac{(c_i + 1)\, c_j + c_i}{2 - (c_i + 1) * 1} = \frac{c_i c_j + c_j + c_i}{1 - c_i} \tag{12}$$

Partial derivative:

$$\begin{cases} \dfrac{\partial p_i}{\partial c_i} = \dfrac{1}{(1 - c_i)^2} \\[2mm] \dfrac{\partial p_i}{\partial c_j} = \dfrac{1 + c_i}{1 - c_i} \end{cases} \tag{13}$$

As $\dfrac{\partial p_i}{\partial c_i} > 0$, the price of a platform is a positive correlation with its marginal cost, namely

the higher marginal cost of the platforms, the higher tariffs will be charged. As for the effect of others' cost, when $c_i > 1$, the price of a platform is a negative correlation with

marginal cost of competitors; when $c_i < 1$, the price of a platform is a positive correlation with marginal cost of competitors. This means platforms have the character of critical capacity.

Conclusion

According to our analysis,Internet platformsare mainly based on the size of the network externalities to conduct game competition. There is a critical mass in the development and competition of platforms. Before the critical mass, the role of external effects of the platform is very small, so it pursues rapid expansion of the size of the users, which can survive and avoid the establishment of failure. After the critical mass, the role of external effects of the platform is larger, so it adopts difference competition based on the size and the expected external behavior of competitors, which is in order to maximize corporate profits.
So Internet platforms need to compete based on the stage.
First, before the critical mass, platforms can adopt a single product or services strategy in order to control costs, as much as possible to attract more customers. It uses cost minimization rather than differentiation strategy to pursuit of rapid growth in user scale.
Second, after reaching critical mass, platforms can adopt a differentiation strategy based network externalities size. It can better meet customers' different demandby providing

different products or services fordifferent customer groups, according tointeractive coefficient.

Deficiency of the paper is mainly to study the game of platforms under deterministic conditions, without considering the uncertainty of the situation. It can be further researched at-risk situations by adding the probability of various events.

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