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Study on Inter-temporal Pricing to Suppress Negative Network Externalities of Merchants in Two-Sided Markets

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Abstract: The problem of dishonest transactions in two-sided markets is increasingly prominent, and its governance mechanism needs to be improved. Pricing strategy is an effective means of platform governance, which can restrain the negative network externalities caused by dishonest transactions. By using the inter-temporal analysis method, this paper analyzes the influence of network externalities in different periods on platform pricing and regulatory costs. The research shows that: from the perspective of platform profit maximization, (1) The greater the positive network externalities of merchants, the lower the platform charges merchants; (2) The greater the negative network externalities caused by dishonest transactions, the higher the platform charges merchants; (3) The greater the network externalities of consumers to merchants, the higher the platform charges merchants. Finally, the influence of cross network externality on platform pricing, platform supervision cost, number of both sides of the platform and platform profit is analyzed by simulation. This provides suggestions for the platform to control merchants' dishonest transaction behavior through pricing.

Key Words: E-commerce, Two-Sided Markets, Network Externalities, Dishonest Transaction, Inter-temporal Pricing

1. Introduction

The 11th "Double Eleven" day of 2019 has passed, headed by Tmall and JD E-commerce platform refresh record again, eventually Tmall total turnover in 268.4 billion, JD accumulative total turnover exceeds 204.4 billion, behind the trading amount reflects the online platform for our life and work more and more important influence. As the Internet economy continues to grow, consumers are not satisfied with the service experience, such as Baidu Wei Zexi incident, food safety issues, and merchants' fraudulent transactions. According to the disclosure of the E-commerce consumption dispute mediation platform, the hot spots of consumer complaints mainly focus on fake promotion, price fraud, product quality, online sales of fake goods, delivery delay, refund problems, and goods wrong board [1]. The negative network externality brought by the dishonest transaction behavior of merchants affects the sustainable development of online shopping platforms and the consumption experience of consumers.

At present, researches on network transaction dishonesty mainly focuses on the dishonesty of both parties and platform governance .In the study of Peng et al. (2011), it was concluded that the honesty of sellers in online transactions is conditional, which is influenced by the benefits and costs of fraud, the degree of information asymmetry, the buyers' perception of honesty and the buyers' tolerance to fraud, and these influencing factors vary with the commodities sold, ultimately affecting the sellers' honesty [2]. Wang et al. (2011) also found out the reasons for the lack of good faith by analyzing the current situation of seller dishonesty, and proposed management measures of seller integrity from three perspectives of characteristics, process and system. Online transactions in addition to the seller's dishonest behavior, there are dishonest behavior of buyers, such as malicious bad review revenge [3]. Shao et al. (2015) studied that the evaluation mechanism of online shopping platforms represented by Tmall is mainly a one-way reputation evaluation mechanism rather than a two-way reputation evaluation mechanism, which leads to the dishonest behavior of buyers [4].

Facing the phenomenon of dishonesty in the online shopping market, the online reputation mechanism is the most widely used in dealing with dishonest transactions. Resnick et al. (2000) studied the reputation system of feedback forum established by eBay, and analyzed the operation principle of the reputation system and its role in reducing dishonest transactions between buyers and sellers[5].Rice (2012) believed that online transaction requires more decision-making information than offline transaction, which leads to more uncertainty in online transaction[6].Therefore, the uncertainty of online transaction plays a part in the effect of reputation evaluation mechanism[6]. Yang et al. (2007) put forward the registration deposit and trading margin mechanism, which dynamically linked the margin before and after the transaction with the reputation index, to achieve the goal of long-term integrity trading [7]. Kang et al. (2016) designed a trusted third-party main body mechanism through registration deposit, fraud penalty and other means, and obtained the conditions of Nash equilibrium for the buyer and seller to participate in honest trading through dynamic game, to deliver collective reputation to the market for a long time and reduce the probability of dishonest transaction [8]. Online shopping platform is found in bilateral market environment, the platform of quality monitoring action into bound by platform benefits and costs, Li et al. (2017) on the basis of studying of Armstrong, build the pricing model of buyers and sellers with cross externalities, it is concluded that

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online shopping platform not only consider online consumers[9]. And online shopping platform improve the registration fee to retain quality to balance the supervision cost to customers [9].

At present, scholars at home and abroad mainly deal with network dishonest transactions by designing various mechanisms, such as reputation mechanism, signal transmission mechanism, margin mechanism and pricing mechanism. However，for two-sided markets through the inter-temporal pricing to reduce dishonest merchants trading behavior problems need to be further research, this article on the basis of predecessors' research, analysis of cycle more two-sided markets through the change of network externalities dynamic adjustment charge and monitoring the businessman, reduce dishonest merchants trading behavior and maintain long-term stable and healthy development.

2. Model Assumption

Based on Armstrong's monopoly platform pricing model [10-11], the following model is established: there is a two-sided platform, with merchants on one side and consumers on the other, and $\mathrm{N_b(t)}$(t=1,2,…,n) represents the number of online consumers in period t, and $N_s(t)$ represents the number of online merchants in period t. As an intermediary, the platform provides services for both sides, helping consumers to buy commodities and merchants to sell commodities. Therefore, the platform charges service fees to both sides. Considering that in reality, most platforms do not charge consumers, this paper assumes that the platform only charges merchants $p(t)$ in period t.

$$p(t) = p_b(t)N_b(t) \qquad (1)$$

Where $p_b(t)$ represents the fee per unit of consumer paid to the platform by the online merchant in period t.

The cross-network externalities of the platform include the network externalities of online consumers to online merchants and the positive/negative network externalities of online merchants to online consumers. $\varphi(\varphi\in(0,1))$ represents the network externalities of online consumers to online merchants, that is, the benefits each consumer brings to the merchants through platform transactions. When the greater the number of online consumers on the host platform, the greater the utility of the online merchant. $v(v\in(0,1))$ represents online merchants for the online consumer's positive network externalities, namely each business through the platform trade benefits to consumers. When the greater the number of online merchants on the host platform, the greater the positive utility of online consumers. $\mu(t)(\mu(t)\in(0,1)$ represents in period t online merchants dishonest transaction to online consumer negative network externalities, namely the period t every merchant's dishonest trade brings the loss of customers. When the greater the number of online merchants on the host platform, the greater the disutility of online consumers.

Then, in order to retain consumers, the platform will invest regulatory cost $e(t)$ to reduce the negative network externalities impact of merchants' dishonest transactions on consumers.

$$e(t) = e_b(t)N_b(t) \qquad (2)$$

Where $e_b(t)$ represents the regulatory cost per unit of period t platform.

Therefore, the negative network externalities brought to consumers by dishonest transactions of merchants in period t-1 can be reduced through the input of regulatory cost of period t-1 platform.

$$\mu(t) = \mu(t-1) - e_b(t) \qquad (3)$$

Based on the above assumptions

The period t consumer's utility $U_b(t)$ is equal to the positive network externalities provided by the period t merchant minus the final negative network externalities brought to the consumer by the period t-1 merchant's dishonest transactions.

$$U_b(t) = [v - \mu(t)]N_s(t) \qquad (4)$$

The utility $U_s(t)$ of the online merchant in period t is equal to the network externalities brought to the merchant by the consumer in period t minus the fees paid to the platform in period t.

$$U_s(t) = \left(\varphi - p_b(t)\right)N_b(t) \qquad (5)$$

The profit of period t platform is equal to the fees charged by period t platform to merchants minus the regulatory costs of period t platform.

$$\prod_{pl}(t) = \left(p(t) - e(t)\right)N_s(t) \qquad (6)$$

The number of consumers on the platform of period t is determined by whether the utility of consumers on the platform is greater than zero.

$$N_b(t) = pr(U_b(t) > 0) = \frac{v-\left(\mu(t-1)-e_b(t)\right)}{v} \qquad (7)$$

The number of online merchants on the platform of period t is determined by whether the merchants' utility after transactions on the platform is greater than zero.

$$N_s(t) = pr(U_s(t) > 0) = \frac{\varphi-p_b(t)}{\varphi} \qquad (8)$$

3. Model Analysis

Proposition 1: The optimal unit price of the platform and the optimal unit regulatory cost of the platform in period t are respectively $p_b^*(t) = \frac{2\varphi-\left(v-\mu(t-1)\right)}{3}$ and $e_b^*(t) = \frac{\varphi-2\left(v-\mu(t-1)\right)}{3}$; On both sides of the platform optimal number of consumers and merchants in period t are respectively $N_b^*(t) = \frac{\varphi+\left(v-\mu(t-1)\right)}{3v}$ and $N_s^*(t) = \frac{\varphi+\left(v-\mu(t-1)\right)}{3\varphi}$.

Proof: Substitute equations (7) and (8) into equation (6) to obtain：

$$\prod_{pl}(t) = \left(p_b(t) - e_b(t)\right)\frac{v-\left(\mu(t-1)-e_b(t)\right)}{v}\frac{\varphi-p_b(t)}{\varphi}.$$

The first derivative of $p_b(t)$ 、 $e_b(t)$ are $\frac{\partial\prod_{pl}(t)}{\partial p_b(t)} = \frac{\left(v-\mu(t-1)+e_b(t)\right)\left(\varphi-2p_b(t)+e_b(t)\right)}{\varphi v}$ and $\frac{\partial\prod_{pl}(t)}{\partial e_b(t)} = \frac{\left(\varphi-p_b(t)\right)\left(-v+\mu(t-1)-2e_b(t)+p_b(t)\right)}{\varphi v}$.

Make $\frac{\partial\prod_{pl}(t)}{\partial p_b(t)} = 0$ and $\frac{\partial\prod_{pl}(t)}{\partial e_b(t)} = 0$, to obtain

$$p_b(t) = \frac{\varphi+e_b(t)}{2} \qquad (9)$$

$$e_b(t) = \frac{-v+\mu(t-1)+p_b(t)}{2} \qquad (10)$$

By combining equations (9) and (10), the optimal unit price and optimal unit cost in the period t are respectively

$$p_b^*(t) = \frac{2\varphi-\left(v-\mu(t-1)\right)}{3} \qquad (11)$$

$$e_b^*(t) = \frac{\varphi-2\left(v-\mu(t-1)\right)}{3} \qquad (12)$$

The corresponding number of online consumers and online merchants in period t are

$$N_b^*(t) = \frac{\varphi+(v-\mu(t-1))}{3v} \quad (13)$$

$$N_s^*(t) = \frac{\varphi+(v-\mu(t-1))}{3\varphi} \quad (14)$$

Discussion: From formula (6), it can be seen that the platform in period t can maximize its own profit by supervising cost input and charging fees to online merchants. To make up for the regulatory costs of inputs, the platform can increase the costs of merchants to charge, but platform can't always increase the supervision cost, online merchants because cost too much and leave platform, finally platform in ($p_b^*(t)$,$e_b^*(t)$) to achieve balance, platform through the pricing and regulation are keeping on both sides of the quantity ($N_b^*(t)$,$N_s^*(t)$) level.

The changes of the optimal unit price, unit regulatory cost, number of consumers and number of merchants in any phase of the platform all change with the different values of network externalities v, negative network externalities $\mu(t)$ brought by merchants to consumers, and network externalities φ brought by consumers. Whether the platform charges merchants and whether it invests regulatory costs to regulate depends on the difference of cross-network externalities generated by consumers and merchants in each period. According to equations (11) and (12), if $2\varphi>v-\mu(t-1)$, the platform of period t can charge merchants. On the contrary, the platform of period t needs to attract merchants to enter the platform through subsidies. If $\mu(t-1)<v-\varphi/2$, period t platform can increase the attraction of merchants more; On the contrary, the platform of period t can invest regulatory costs to protect the interests of consumers.

According to equations (13) and (14), if $\varphi>\mu(t-1)$, that is, in the past, consumers gain more to merchants than merchants lose to consumers, then consumers on the platform of period t will still choose to join the platform for transactions. Due to the increase of merchants' target market, merchants will also choose to enter the platform for transactions. On the contrary, as the target market of merchants shrinks, some merchants will leave the platform and no longer conduct transactions. If $v>\mu(t-1)$, that is, the profits provided by merchants to consumers in the past are greater than the losses, then consumers and merchants on the platform of period t will choose to enter the platform for transactions. Conversely, merchants cheat consumers in order to gain short-term benefits, then some consumers on the platform of period t will choose to leave the platform and no longer conduct transactions. As time goes on, merchants lose profits, and merchants on the platform also choose to leave the platform.

Proposition 2: The optimal unit price of the platform $p_b^*(t)$ and the optimal unit regulatory cost of the platform $e_b^*(t)$, decrease as the positive network externalities v of the merchant to the consumer increases.

Proof: The positive network externalities v of merchants to consumers is obtained by taking the first-order derivative of the platform's optimal unit price $p_b^*(t)$ and optimal unit regulatory cost $e_b^*(t)$ respectively:

$$\frac{\partial p_b^*(t)}{\partial v} = -\frac{1}{3} < 0 \quad (15)$$

$$\frac{\partial e_b^*(t)}{\partial v} = -\frac{2}{3} < 0 \quad (16)$$

Equations (15) and (16) show that the greater the positive network externalities v of merchants to consumers, the greater the attraction of merchants to consumers. Then, the platform can reduce the charges for merchants, and reduce the supervision of merchants, so as to increase the net profit per unit of the platform.

Proposition 3: The optimal unit price of the platform $p_b^*(t)$ and the optimal unit regulatory cost of the platform $e_b^*(t)$, increase with the increase of consumers' network externalities φ to merchants.

Proof: The network externalities φ of consumers to merchants the optimal unit price of the platform $p_b^*(t)$and optimal unit regulatory cost $e_b^*(t)$, are derived:

$$\frac{\partial p_b^*(t)}{\partial \varphi} = \frac{2}{3} > 0 \quad (17)$$

$$\frac{\partial e_b^*(t)}{\partial \varphi} = \frac{1}{3} > 0 \quad (18)$$

Formula (17) and (18) indicate that the greater the network externalities φ of consumers to merchants in the platform, the greater the attraction of consumers to merchants. The platform can raise the fee for merchants, and can also improve the supervision of merchants, so as to increase the net income per unit of the platform.

Proposition 4: The optimal unit price of the platform$p_b^*(t)$ and the optimal unit regulatory cost of the platform $e_b^*(t)$, increase with the increase of negative network externalities $\mu(t-1)$ brought by dishonest transactions by merchants in the past.

Proof: The dishonest transactions of merchants in period t-1 generate negative network externalities to consumers $\mu(t-1)$. The first derivative of the optimal unit price $p_b^*(t)$ and optimal unit effort $e_b^*(t)$ of platform in period t is obtained

$$\frac{\partial p_b^*(t)}{\partial \mu(t-1)} = \frac{1}{3} > 0 \quad (19)$$

$$\frac{\partial e_b^*(t)}{\partial \mu(t-1)} = \frac{2}{3} > 0 \quad (20)$$

Negative network externalities dimension $\mu(t-1)$ of the dishonest transactions of merchants in period t the optimal quantity of consumers $N_b^*(t)$and the optimal quantity of merchants $N_s^*(t)$ on both sides of the platform in period t-1 are derived to the first order

$$\frac{\partial N_b^*(t)}{\partial \mu(t-1)} = -\frac{1}{3v} < 0 \quad (21)$$

$$\frac{\partial N_s^*(t)}{\partial \mu(t-1)} = -\frac{1}{3\varphi} < 0 \quad (22)$$

Equations (19) and (20) show that the greater the negative network externalities $\mu(t-1)$ brought by dishonest transactions by merchants to consumers in the past, the higher the platform's charges for merchants and the higher the supervision of merchants, thus reducing the net income per unit of the platform.

According to equations (21) and (22), the larger the number of negative network externalities $\mu(t-1)$ brought by dishonest transactions by merchants to consumers, the smaller the number of consumers and merchants on the platform. On the contrary, the greater the number of consumers and merchants on the platform.

4. Numerical Analysis

In order to further analyze the influence of consumers on network externalities of merchants, positive network externalities of merchants on consumers and negative network externalities brought by dishonest transactions of merchants on platform pricing and regulatory cost input, this section uses *MatLab* for numerical simulation analysis.

Case 1: Make μ=0.1, that is, platform negative network externalities have less impact. Analyze the impact of φ and v on platform unit pricing, unit regulatory cost, number of platforms on both sides and platform profit, and get figures 1 to 5:

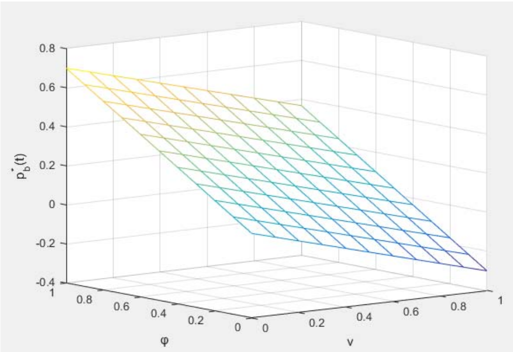

Fig. 1: The effect of φ and v on $p_b^*(t)$

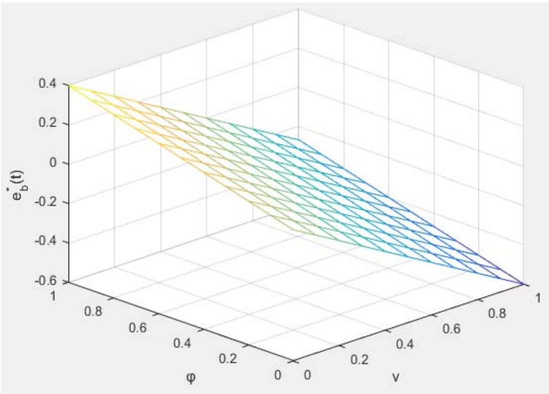

Fig. 2: The effect of φ and v on $e_b^*(t)$

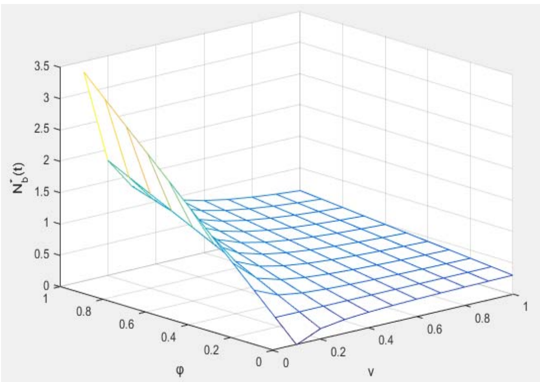

Fig. 3: The effect of φ and v on $N_b^*(t)$

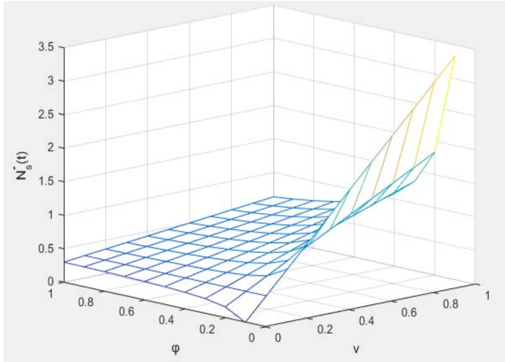

Fig. 4: The effect of φ and v on $N_s^*(t)$

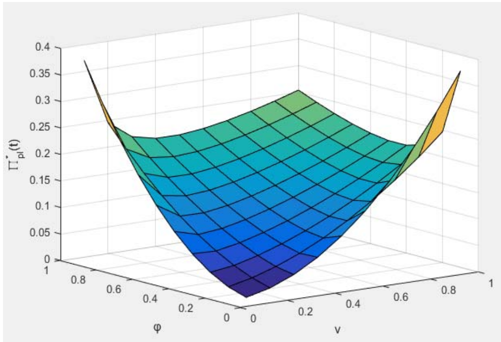

Fig. 5: The effect of φ and v on $\prod_{pl}^*(t)$

When φ=0.9, v=0.3, it can be concluded from formula (11) that the platform charges merchants $p_b^*(t)$=1.6/3, as shown in figure 1;According to formula (12), the regulatory cost of platform input $e_b^*(t)$=0.5/3, as shown in figure 2;According to formula (13), the number of consumers on the platform $N_b^*(t)$=11/9, as shown in figure 3;According to formula (14), the number of merchants on the platform $N_s^*(t)$=11/27, as shown in figure 4; From formula (6), platform profit $\prod_{pl}^*(t)$=133.1/729, as shown in figure 5.

When φ=0.6, v=0.3, it can be concluded from formula (11) that the platform charges merchants the highest $p_b^*(t)$=1/3, as shown in figure 1;According to formula (12), the maximum regulatory cost of platform input is $e_b^*(t)$=0.2/3, as shown in figure 2.According to formula (13), the number of consumers on the platform $N_b^*(t)$=8/9, as shown in figure 3;According to formula (14), the number of merchants on the platform $N_s^*(t)$=4/9, as shown in figure 4;From formula (6), platform profit $\prod_{pl}^*(t)$=25.6/243, as shown in figure 5.

When φ=0.9, v=0.5, it can be concluded from formula (11) that the platform charges merchants $p_b^*(t)$=1.4/3, as shown in figure 1;According to formula (12), the regulatory cost of platform input $e_b^*(t)$=0.1/3, as shown in figure 2;According to formula (13), the number of consumers on the platform $N_b^*(t)$=13/15, as shown in figure 3;According to formula (14), the number of merchants on the platform $N_s^*(t)$=13/27, as shown in figure 4;From formula (6), platform profit $\prod_{pl}^*(t)$=219.7/1215, as shown in figure 5.

Therefore, when the negative network externalities of the platform is relatively small, the greater the network externalities of consumers to merchants, the higher the platform charges merchants and the greater the investment in the supervision cost of merchants, so as to maximize the profit of the platform and the number of consumers. The greater the positive network externalities of merchants to consumers, the lower the platform charges merchants and the less investment in the supervision cost of merchants, so as to maximize the platform profit and the number of merchants.

Case 2: Analyzing the influence of $\mu(t\text{-}1)$ on unit pricing, unit regulatory cost, quantity on both sides of the platform and platform profit of the platform, table 1 to table 4 (three decimal places are reserved for the calculation results) and figure 6 are obtained:

Table 1: When the $v = 0.5$, $\varphi = 0.6$, the effect of $\mu(t\text{-}1)$ on $p_b^*(t)$, $e_b^*(t)$, $N_b^*(t)$, $N_s^*(t)$ and $\prod_{pl}^*(t)$

	$\mu(t\text{-}1)$	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
	$p_b^*(t)$	0.233	0.267	0.300	0.333	0.367	0.400	0.433	0.467	0.500	0.533	0.567
v=0.5	$e_b^*(t)$	-0.133	-0.067	0.000	0.067	0.133	0.200	0.267	0.333	0.400	0.467	0.533
φ=0.6	$N_b^*(t)$	0.733	0.667	0.600	0.533	0.467	0.400	0.333	0.267	0.200	0.133	0.067
	$N_s^*(t)$	0.611	0.556	0.500	0.444	0.389	0.333	0.278	0.222	0.167	0.111	0.056
	$\prod_{pl}^*(t)$	0.164	0.123	0.090	0.063	0.042	0.027	0.015	0.008	0.003	0.001	0.000

Table 2: When the $v = 0.6$, $\varphi = 0.7$, the effect of $\mu(t\text{-}1)$ on $p_b^*(t)$, $e_b^*(t)$, $N_b^*(t)$, $N_s^*(t)$ and $\prod_{pl}^*(t)$

	$\mu(t\text{-}1)$	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
	$p_b^*(t)$	0.267	0.267	0.300	0.333	0.367	0.400	0.433	0.467	0.500	0.533	0.567
v=0.6	$e_b^*(t)$	-0.167	-0.100	-0.033	0.033	0.100	0.167	0.233	0.300	0.367	0.433	0.500
φ=0.7	$N_b^*(t)$	0.722	0.667	0.611	0.556	0.500	0.444	0.389	0.333	0.278	0.222	0.167
	$N_s^*(t)$	0.619	0.571	0.524	0.476	0.429	0.381	0.333	0.286	0.238	0.190	0.143
	$\prod_{pl}^*(t)$	0.194	0.140	0.107	0.079	0.057	0.040	0.026	0.016	0.009	0.004	0.002

Table 3: When the $v = 0.7$, $\varphi = 0.8$, the effect of $\mu(t\text{-}1)$ on $p_b^*(t)$, $e_b^*(t)$, $N_b^*(t)$, $N_s^*(t)$ and $\prod_{pl}^*(t)$

	$\mu(t\text{-}1)$	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
	$p_b^*(t)$	0.300	0.333	0.367	0.400	0.433	0.467	0.500	0.533	0.567	0.600	0.633
v=0.7	$e_b^*(t)$	-0.200	-0.133	-0.067	0.000	0.067	0.133	0.200	0.267	0.333	0.400	0.467
φ=0.8	$N_b^*(t)$	0.714	0.667	0.619	0.571	0.524	0.476	0.429	0.381	0.333	0.286	0.238
	$N_s^*(t)$	0.625	0.583	0.542	0.500	0.458	0.417	0.375	0.333	0.292	0.250	0.208
	$\prod_{pl}^*(t)$	0.223	0.181	0.145	0.114	0.088	0.066	0.048	0.034	0.023	0.014	0.008

Table 4: When the $v = 0.7$, $\varphi = 0.8$, the effect of $\mu(t\text{-}1)$ on $p_b^*(t)$, $e_b^*(t)$, $N_b^*(t)$, $N_s^*(t)$ and $\prod_{pl}^*(t)$

	$\mu(t\text{-}1)$	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
	$p_b^*(t)$	0.333	0.367	0.400	0.433	0.467	0.500	0.533	0.567	0.600	0.633	0.667
v=0.8	$e_b^*(t)$	-0.233	-0.167	-0.100	-0.033	0.033	0.100	0.167	0.233	0.300	0.367	0.433
φ=0.9	$N_b^*(t)$	0.708	0.667	0.625	0.583	0.542	0.500	0.458	0.417	0.375	0.333	0.292
	$N_s^*(t)$	0.630	0.593	0.556	0.519	0.481	0.444	0.407	0.370	0.333	0.296	0.259
	$\prod_{pl}^*(t)$	0.253	0.211	0.174	0.141	0.113	0.089	0.068	0.051	0.038	0.026	0.018

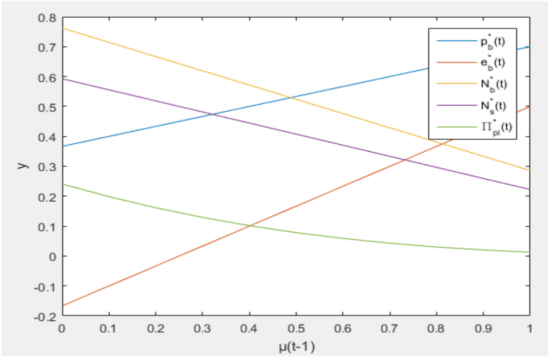

Fig. 6: When the $v = 0.7$, $\varphi = 0.9$, the effect of $\mu(t\text{-}1)$ on $p_b^*(t)$, $e_b^*(t)$, $N_b^*(t)$, $N_s^*(t)$ and $\prod_{pl}^*(t)$

When $\mu(t\text{-}1)$=0.1, the platform charges merchants $p_b^*(t)$=0.4 from formula (11), the regulatory cost of platform input $e_b^*(t)$ =-0.1 from formula (12), the number of consumers on the platform $N_b^*(t)$=5/7 from formula (13), the number of merchants on the platform $N_s^*(t)$=5/9, and the platform profit $\prod_{pl}^*(t)$=12.5/63 from formula (6), as shown in figure 6.

When $\mu(t\text{-}1)$=0.5, the platform charges merchants $p_b^*(t)$=1.6/3 from formula (11), the regulatory cost of platform input $e_b^*(t)$=0.5/3 from formula (12), the number of consumers on the platform $N_b^*(t)$=11/21 from formula (13), the number of merchants on the platform $N_s^*(t)$=11/27, and the platform profit $\prod_{pl}^*(t)$=12.1/1701 from formula (6), as shown in figure 6.

When $\mu(t\text{-}1)$=0.9, the platform charges merchants $p_b^*(t)$=2/3 from formula (11), the regulatory cost of platform input $e_b^*(t)$ =1.3/3 from formula (12), the number of consumers on the platform $N_b^*(t)$=1/3 from formula (13), the number of merchants on the platform $N_s^*(t)$=7/27 from formula (6), and the platform profit $\prod_{pl}^*(t)$=4.9/243, as shown in figure 6.

Therefore, the greater the negative network externalities of the platform, the higher the platform charges merchants, or the higher the regulatory cost input.

5. Summary and Prospect

According to the size of the cross-network externalities generated by the two sides, the platform can deal with merchants' dishonest transactions dynamically through pricing and supervision. After modeling and numerical analysis, the following two conclusions are obtained:

1. When the platform's negative network externalities are fixed in the past, the impact of negative network externalities can be further reduced by improving the network externality of consumers to merchants and the positive network externality of merchants to consumers.

On the one hand, raising consumer network externalities to the businessman to raise fees to the businessman and strengthen supervision to the businessman, such as increase subsidies for consumers (red envelopes and coupons), improve the merchant fees (increase the registration fee and transaction fee), improve supervision technology platform, attract consumers into the trading platform.

On the other hand, increasing the positive network externalities of merchants to consumers can reduce the charges and supervision of merchants. The platform can raise the threshold for merchants to enter and select high-quality merchants to enter the platform. For example, the stores of Tmall should be registered in the name of the company, while Taobao only requires the name of the individual. If we opened a store in Tmall or Taobao, Tmall charged more margin than Taobao.

2. In order to reduce the impact of negative network externalities, the platform can reduce the input of merchants' fees and regulatory costs and expand the number of bilateral businesses. For merchants with high reputation evaluation, the platform will reduce the next charge and name the merchants exempted from inspection. In this way, the platform can not only meet the maximization of profits, but also maintain the overall integrity level of the platform for a long time.

However, the research also has some shortcomings. In the future, the main research direction is to consider the competition platform to deal with the dishonest transactions behavior of merchants. Nowadays, there are many E-commerce platforms in the market, such as Tmall, Taobao, JD and Pinduoduo. These E-commerce platforms are integrated E-commerce platforms of the first camp. There are also many market segments for E-commerce platforms, such as Beibei.com, JUMEI and so on. In the competition platform, we can specifically study that merchants have different negative network externalities, how does the platform deal with the dishonest transactions behavior of merchants? How does the platform deal with the dishonest transactions behavior of merchants under different ownership of bilateral users of the platform?

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