Evolutionary Game of Counterfeit between Industrial E-commerce Third-Party Platform and Settled Merchants under New Media Environment

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Abstract. Settled merchants counterfeiting on industrial e-commerce platform have become the focus of government and media. To analysis the evolutionary mechanism of counterfeiting between industrial e-commerce platform and settled merchants under New Media environment, an evolutionary game model was built. The influence and authenticity of New Media reports were taken into account in the counterfeit game between platform and settled merchants. The research shows that the influence and authenticity of New Media reports have a significant impact on the evolution of counterfeit on industrial e-commerce platform. The third-party platforms tend to supervise and the settled merchants tend to legitimate operation under efficient and accurate New Media environment. Meanwhile, third-party platforms tend to ignore supervision and settled merchants tend to counterfeit when New Media reports lack credibility. So, enhancing the supervision and improving the authenticity of New Media have a positive effect on counterfeiting in the third-party industrial e-commerce platform.

Introduction

Industrial e-commerce (IEC) is a new type of economic activity centering on network transactions of information, products, services, resources and capabilities in the industrial field. IEC throughout product lifecycle covered research & development, design, procurement, production, sales, service and recycling. The development of IEC conducive to industrial business transaction and management pattern of online, promote products for manufacturing process, the whole industry chain, the whole lifecycle of information interaction and integration collaboration. Along with the development of industrial e-commerce, settled merchants’ counterfeit on industrial e-commerce platform have become the focus of whole society gradually.

The unreasonable distribution of benefits and moral hazard are the main factors for the counterfeit on industrial e-commerce platform. He believes that in the case of operators with bilateral moral hazard, the non-prepayment of interest distribution is more effective in stimulating the efforts of both parties [1]. Cheng use virtual third-party methods study the incentive and coordination when moral hazard and adverse selection existed in the supply chain [2]. Egri designed a supply chain coordination model that can satisfy multiple constraints in the case of bilateral adverse selection [3]. Kloyer study the role of incentive and reward mechanism to prevent moral hazard in joint Research & Development [4]. Xu analyzes the evolutionary mechanism of interaction between participants in the supply chain with moral hazard by network method [5]. Wang believes that the revenue game in alliance members is not only a game between internal members, but also related to the benefits of external members [6]. The platform and the settled merchants are the community of interests and the competitors of interest game. The counterfeit cannot be solved by simply regulating the supervision responsibility of the e-commerce third-party platform [7].
New Media developed after traditional media, such as newspapers, radio, and television, has the advantages of quickly share information, optionality and interactivity. Everyone can quickly become the originator and communication intermediary of the information through community applications, such as Weibo, WeChat, Facebook and Tweet. Due to vast amount of information are difficult to verify on Internet, steep competition between the medias and the decline of work ethic driven by profit, false reports on counterfeit run rampant at New Media. Therefore, based on the duality of New Media, it is important to study the dissemination efficiency and accuracy of New Media on counterfeit.

This paper built an asymmetric evolutionary game model of counterfeiting game to study the dynamic strategy choices of third-party e-commerce platform and settled merchants under bounded rationality, taking the influence and authenticity of New Media into account. The influence mechanism of New Media on the strategic choice of counterfeit is analyzed according to the evolutionary stability theory.

Description and Hypothesis
Description
Counterfeit on industrial e-commerce third-party platform include not only fake products and service, but also consumption fraud. The scandal of mainstream B2C e-commerce platform selling fake goods is not rare, the community has never stopped questioning the e-commerce platform "known to sell fake goods".

The strategy set of platforms include supervise counterfeiting seriously (SCS) on the platform, and do not supervise counterfeiting on the platform (NSC). The settled merchants' strategy set include take counterfeiting (TC) and do not take counterfeiting (NTC) on the platform.

The notations discussed in details as follows.

\( x \), the probability of the platform taking SCS strategy. Then, the probability of taking NSC strategy at time \( t \) is \( 1 - x \), \( 0 \leq x \leq 1 \).

\( y \), the probability of settled merchants sells genuine product on the platform. Then, the probability of settled merchant counterfeiting on platform at time \( t \) is \( 1 - y \), \( 0 \leq y \leq 1 \).

\( C_x \), the cost of platform NTC strategy to deal with counterfeiting. \( C_x > 0 \).

\( C_{1-x} \), the cost of settled merchants taking TC strategy. \( C_{1-x} > 0 \).

\( R_1 \), the revenue of the settled merchant taking TC strategy. \( R_1 \geq 0 \).

\( R_2 \), the revenue of settled merchant taking NTC strategy when platform take NSC strategy.

\( R_3 \), the revenue of settled merchant taking TC strategy, when platform take NSC strategy.

\( C_y \), the cost of e-commerce platform taking SCS strategy. \( C_y > 0 \)

\( C_{1-y} \), the cost of e-commerce platform taking NSC strategy. \( C_{1-y} < C_y \).

\( P_x \), the punished loss of settled merchant report falsely by New Media, when taken NTC strategy, but report falsely taken TC strategy by New Media.

\( P_{1-x} \), the punished loss of settled merchant when taking TC strategy and report by New Media. \( P_{1-x} > 0 \)

\( P_y \), the reputational reward of e-commerce platform. The e-commerce platform win reputation rewards when it always taking SCS strategy and report by New Media.

\( P_{1-y} \), the reputational loss of e-commerce platform reported by New Media, when the e-commerce platform taken NSC strategy.

\( \alpha \), the influence of New Media. If the value of traditional media is 1 then \( \alpha > 1 \).

\( \beta \), the authenticity. The authenticity of the New Media report on counterfeiting. The value range of authenticity in New Media is \([0,1]\).
Hypothesis

Hypothesis 1: New Media will report the counterfeiting, as long as the settled merchant taken TC strategy to counterfeiting. If the e-commerce platform did not take SCS strategy New Medial will also report the counterfeiting, even the settled merchant taken NTC strategy.

Hypothesis 2: If the e-commerce platforms keep taking SCS strategy, the settled merchant taken TC will be reported. The cost of e-commerce platform taking SCS is \(C_y\). If the e-commerce platform take SCS strategy and the settled merchant take NTC strategy, New Media reports will no effect on the e-commerce platform and settled merchants’ reputation.

Hypothesis 3: New Media have more influence than traditional media due to its free, rapid and wide spread. If the influence of traditional media is 1, then \(\alpha > 1\)

Hypothesis 4: If the e-commerce platforms keep taking SCS strategy strictly and seriously, the reports of New Media have no influence on the e-commerce platform’s reputation.

The following factors on the notarization of New Media reports need to be considered.

1. The reputation loss of settled merchant is \((1 - \beta)P_{1-y}\), and the reputational loss of e-commerce platform is \((1 - \beta)P_x\), when the settled merchant take NTC strategy and the e-commerce platform take SCS strategy reported falsely to counterfeiting by New Media.

2. If New Media report the counterfeiting correctly, the settled merchant’s punished loss is \(\beta P_{1-y}\), and the reputational loss of the e-commerce platform is \(\beta P_{1-x}\).

Based on the assumptions, we can get the payoff matrix of e-commerce platforms and settled merchants under different strategy choices, shown in Table.1:

| Platforms/settled merchants | NTC(x) | TC(1-x) |
|-----------------------------|--------|---------|
| SCS(y)                      | \((R_1 - C_x, -C_y)\) | \((R_1 - C_{1-x}, P_y - C_y)\) |
| NSC(1-y)                    | \((-C_y - (1 - \beta)\alpha P_x, -C_{1-y} - (1 - \beta)\alpha P_{1-y})\) | \((R_3 - C_{1-x} - \beta \alpha P_{1-x}, -C_{1-y} - \beta \alpha P_{1-y})\) |

Table 1. Payoff Matrix of doctor-settled merchant counterfeiting.

Modeling

We can get the differential kinetic equation of counterfeiting game according to Table.1.

\[
\begin{align*}
\frac{dx}{dt} &= x(1-x)[C_x - C_{x-1} + y(R_3 - R_2 - C_x - \alpha \beta P_{1-x})] \\
\frac{dy}{dt} &= y(1-y)[2\alpha \beta P_{1-y} - \alpha P_{1-y} + x(-P_y - \alpha P_{1-y})]
\end{align*}
\]

Set \(\frac{dx}{dt} = 0, \frac{dy}{dt} = 0\), formula (1) have 5 equilibrium points: \((0,0), (0,1), (1,0), (1,1), (x_0, y_0)\).

According to Friedman’s approach, the determinant value and the trace of equilibrium points shown in table.2. \(DetJ\) is the value of determinant, \(TrJ\) is the trace of Jacobian Matrix.

Table 2. The value and trace of Jacobian matrix in equilibrium points.

| ESS      | DetJ                  | TrJ                  |
|----------|-----------------------|----------------------|
| (0,0)    | \(-\alpha P_{1-y}(R_1 - R_3 + \alpha \beta P_{1-x})\) | \((R_1 - R_3 + \alpha \beta P_{1-x} - \alpha P_{1-y})\) |
| (0,1)    | \(-\alpha P_{1-y}(R_1 - R_3 + \alpha \beta P_{1-x})\) | \((R_1 - R_3 + \alpha \beta P_{1-x} - \alpha P_{1-y})\) |
| (1,0)    | \(-\alpha P_{1-y}(R_1 - R_3 + \alpha \beta P_{1-x})\) | \((R_1 - R_3 + \alpha \beta P_{1-x} - \alpha P_{1-y})\) |
| (1,1)    | \(-\alpha P_{1-y}(R_1 - R_3 + \alpha \beta P_{1-x})\) | \((R_1 - R_3 + \alpha \beta P_{1-x} - \alpha P_{1-y})\) |
| \((x_0, y_0)\) | M                     | 0                    |

Analysis of 5 possible equilibrium points’ stability get follow propositions:
(1) When \( \max\left(1, \frac{R_3 - R_1}{\beta p_{1-x}}\right) < \alpha < \frac{R_3 - R_1}{\beta p_{1-x} - p_{1-y}} \), the system has an evolutionary stability strategy (ESS) \((0,0)\).

(2) When \( 1 < \alpha < \frac{R_2 - R_1}{(1-\beta)p_x + (1-2\beta)p_{1-y}} \), the system has an ESS \((0,1)\).

(3) When \( \max\left(1, \frac{C_y - C_{1-y}}{1-\beta}p_{1-y}\right) < \alpha < \frac{R_3 - R_x + C_y - C_{1-y}}{(1-2\beta)p_{1-x}} \), the system has an ESS \((1,0)\).

(4) When \( \alpha > \frac{R_2 - R_1 - (C_y - C_{1-y})}{(1-\beta)(p_x + p_{1-y})} \), the system has an ESS \((1,1)\).

**System Analysis**

(1) Point \((0,0)\) is the ESS of the system. E-commerce platforms keep taking SCS strategy and settled merchants keep taking TC strategy when \((0,0)\) is the ESS of the system. Meanwhile, e-commerce platforms tend to ignore the counterfeit when the cost of SCS strategy more than the cost of NSC strategy. Fig.1A indicates that no matter what strategy the other participants take, NSC and TC strategies can get better revenue. When the settled merchants keep taking TC strategy and the e-commerce platform have to take NSC strategy. When the parameter \(\alpha\) and \(\beta\) increase gradually, that harmful equilibrium will be broken and the evolutionary result will be revised.

**Conclusion 1:** When the revenue of taking TC strategy more than the revenue of taking NTC strategy, settled merchants tend to take TC strategy. New Media affect the strategy selection of e-commerce platform and settled merchants, along with the increasing influence and authenticity of New Media.

![Figure 1. The ESS of counterfeiting game.](image)

(2) Point \((0,1)\) is the ESS of the system.

According to Fig.1 B, settled merchants tend to take TC strategy when the revenue of taking NTC strategy reported falsely more than the revenue of taking TC strategy reported correctly by New Media. Meanwhile, e-commerce platforms tend to take SCS strategy when the loss of taking SCS strategy less than the loss of taking NSC strategy reported by New Media. If the e-commerce platforms always take SCS strategy, the equilibrium will be broken along with the increase of \(\alpha\) and \(\beta\). New Media reports will be a reputation reward for the e-commerce platform if platform always supervising.

**Conclusion 2:** New Media effectively restrict the settled merchants’ strategy selection in one hand, and promote the standardization of e-commerce platform to supervise counterfeit in other hand, along with the increasing influence and authenticity of New Media.

(3) Point \((1,0)\) is the ESS of the system.

According to the evolutionary phase diagram of Fig.1 C, settled merchants tend to take NTC strategy when the revenue of wrong reports more than the revenue of taking TC strategy reported by New Media, if the e-commerce platform taken NSC strategy. Meanwhile, e-commerce platforms tend to take NSC strategy when the loss of SCS strategy less than the loss of NSC strategy reported by New Media. New Media have both positive and negative influence on the evolution of counterfeiting. The authenticity of reports along with the increasing influence of New Media improve settled merchants taking NTC strategy and e-commerce platforms taking SCS strategy. The equilibrium will be broken along with the increase of \(\alpha\) and \(\beta\).
**Conclusion 3:** The authenticity of New Media is the key factor that influence the strategy selection of e-commerce platforms and settled merchants. The increasing authenticity of New Media will improve the e-commerce platform taking SCS strategy.

(4) Point (1,1) is the ESS of the system.

Settled merchants tend to take NTC strategy when the revenue of taking NTC strategy more than the revenue of taking TC strategy reported by New Media, if e-commerce platform always taking SCS strategy. Meanwhile, e-commerce platforms tend to take SCS strategy when the cost of taking SCS strategy less than the cost of taking NSC strategy reported by New Media, if settled merchants always taking NTC strategy. That is an ideal evolution shown as fig.1 D, settled merchant tend to take NTC strategy and e-commerce platform tend to take SCS strategy.

**Conclusion 4:** The rapid development of New Media improves the relatively free self-media environment, which force e-commerce platforms adopting SCS strategy regardless of settled merchants taken NTC strategy, when the authenticity of New Media is difficult to distinguish.

**Summary**

In this paper, the evolutionary mechanism of settled merchant counterfeiting on industrial e-commerce platform under New Media environment was analyzed. New Media improves the rapid and wide spread of counterfeiting information compare to traditional media. New Media has both positive and negative effects on counterfeiting game due to the distortion of partial reports. Higher authenticity of New Media can effectively restrain the settled merchant counterfeiting, urge e-commerce platforms to regulate counterfeiting on platform. The distortion of New Media reports has a negative impact on counterfeiting, which not only hinder the e-commerce platform regulating, but also promote the settled merchant counterfeiting. Therefore, the authenticity of New Media is one of the key factors affect the evolution of counterfeiting game between platform and settled merchant.

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