Research on Optimal Anti-money Laundering Model Based on E-Commerce Environment

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Abstract. This study will be online anti-money laundering as the research object. According to the characteristics of China's online money laundering, and build a game model composed of money laundering people, third party payment institutions, commercial banks and regulatory agencies. This model is used to analyze the social welfare loss caused by “money laundering” and “anti-money laundering”. Based on the cost-benefit analysis and game theory, this paper studies the utility function and behavior strategies of market players, and the model is simulated, and put forward relevant policy and recommendations to curb online money laundering.

Introduction

Money laundering refers to the illegal income through the covert means to re-enter the economic system and financial system and make it in the form of “legalization” behavior and process [1]. From the degree of social harm, money laundering has a negative impact on the national economy, financial order and social stability. OuYang [2] believes that all financial activities that are associated with serious crime, especially organized crime, should be regarded as money laundering. Money laundering causes the country to suffer the economic loss, may cause the economic turbulence, causes the financial crisis, provides the financial resources for the international terrorism. Therefore, the anti-money laundering is of great significance to safeguard the reputation of the national financial institutions, improve the level of risk control, reduce legal risks and operational risks, and ensure the stability of the national financial system.

In this paper, we will take the anti-money laundering behavior of online payment as the research object, and the anti-money laundering game model is constructed by money laundering people, the regulatory agencies, the commercial banks and the third party payment agencies, and their utility functions are described. Based on the cost-benefit analysis and game theory, this paper studies the main factors that influence the utility function of various subjects and their behavior strategies, and puts forward relevant policy suggestions.

Construct Game Model

In this paper, we construct a game model to describe the income function of money laundering people, third party payment institutions, commercial banks and regulatory agency.

Income Function of Money Laundering People

Money laundering people may take money laundering or not money laundering. In order to change the “illegal income” into “legalization income”, the money laundering people will hire others or directly take participate in the money laundering. “Illegal income” was washed clean after that it has a legitimate value, in order to enter the legitimate economic system. Money laundering people costs include: labor costs, taxes paid, formal commissions paid to financial institutions, investment losses, silent commissions paid to financial institutions, etc. [3].
**Hypothesis 1:** Assuming that all online payment transactions in time \( t \in [t_1, t_2] \) period, money laundering people money laundering times, its set is: \( \mathbb{X} = \{ \mathbb{X}_1, \mathbb{X}_2, \ldots, \mathbb{X}_i \} \). The total amount of money laundering: \( \mathcal{X}_L \), it accounts for the proportion of the total online payment business is \( \mu \), \( 0 < \mu < 1 \), that is: \( \mathcal{X}_L = \mu \mathcal{N} \). Drawing lessons Yang Dongmei's [4] research methods, assuming that the cost of money laundering is the quadratic function of amount of money laundering, that is: \( C_L = \beta_i \mathcal{X}_L^2 + \lambda_i \), and \( \lambda_i > 0 \), \( C_L \) is the fixed cost of money laundering, \( 0 < \beta_i < 1 \). Assuming that \( P \) is the probability that money laundering is directly investigated by regulators. Money laundering people is investigated, its set is: \( \mathbb{N}' \subseteq \mathbb{N} \), be investigated for the amount of: \( \mathcal{X}_G = \mu_i \mathcal{X}_L \), \( \mu_i \) is the proportion of money laundering being investigated, it represents the intensity of regulatory inspections. If commercial banks and third party payment agencies to self-check and report, then check the money laundering people behavior set is: \( \mathbb{N}'' \subseteq \mathbb{N} \), and \( \mathbb{N}'' \cap \mathbb{N}' = \emptyset \). The amount of money laundering is checked: \( \mathcal{X}_C = \mu_2 \mathcal{X}_L \), \( \mu_2 \) is the proportion of self-checking of money laundering, it represents the intensity of market active anti-money laundering. When the anti-money laundering effect is the same, if the market for anti-money laundering inspection efforts, the more money laundering behavior was reported, the more able to reduce the difficulty of the work of the anti-money laundering regulators, regulatory agencies will directly reduce the intensity of inspections. Assuming that the market through self-examination and direct inspection of regulatory agencies, they can eliminate the proportion of money laundering is \( \delta \). That is \( \mu_2 = \delta \mu_1 - \mu_2 \). According to the cost and benefit of money laundering people, the expected utility function:

\[
F_{W_L} = \mathcal{X}_L - p \mathcal{X}_G - \mathcal{X}_L - \beta_i \mathcal{X}_L^2 - \lambda_i
\]

After finishing:

\[
F_{W_L} = -\beta_i \mathcal{X}_L^2 + (1 - \mu_i p - \mu_2) \mathcal{X}_L - \lambda_i
\]

**The Utility Function of Third Party Payment Institution and Commercial Bank**

Third party payment institutions and commercial banks can take anti-money laundering or not anti-money laundering. The performance of anti-money laundering obligations need to bear the cost of: organizational costs, operating costs, institutional costs, indirect costs and additional costs, etc.

**Hypothesis 2:** Assume that commercial banks through the inspection found and reported the behavior of money laundering people, its set is: \( \mathbb{P}_B \subseteq \mathbb{P} \), the amount involved is: \( \mathcal{X}_B = \mu_3 \mathcal{X}_L \), \( \mu_3 \geq 0 \) is the degree of active anti-money laundering by commercial banks. Commercial banks active anti-money laundering costs:

\[
\sum C^1_B = \lambda_B \mathcal{X}_B^2 + C_B \quad \text{and} \quad \lambda_B > 0, C_B > 0
\]

fixed costs for anti-money laundering by financial institutions. Assume that third party payment institution through inspection found and reported the behavior of money laundering, its set is: \( \mathbb{P}_P \subseteq \mathbb{P} \), the amount involved is: \( \mathcal{X}_P = \mu_4 \mathcal{X}_L \), \( \mu_4 \geq 0 \) is the degree of active anti-money laundering by third party payment institution. Third party payment institution active anti-money laundering costs:

\[
\sum C^1_P = \lambda_P \mathcal{X}_P^2 + C_P \quad \text{and} \quad \lambda_P > 0, C_P > 0
\]

fixed costs for anti-money laundering by third party payment institution. Because of the commercial bank and third party payment institutions are interconnected in the business, when the regulatory agency received a commercial bank or third party payment institutions in any of the parties to report about suspicious money laundering, regulatory agency will be based on the information reported to require the other party to cooperate with the anti-money laundering investigation. If the two sides report consistent information (i.e.: \( \mathbb{P}_B = \mathbb{P}_P \), \( \mathcal{X}_B = \mathcal{X}_P \)), and they do not have to carry out additional anti-money laundering investigation. Then the regulatory agency adopt the anti-money laundering strategy through the coordination of commercial banks and third party payment agencies, its set is:
The above has been assumed due to commercial banks and third party payment agencies self-examination and report, which was investigated for the amount of money laundering is \( \mathcal{K}_c \), and \( \mathcal{K}_c \leq \mathcal{X}_B + \mathcal{X}_P \). Then the commercial banks continue to investigate the cost of: \( \mathcal{X}_B = \mathcal{X}_C - \mathcal{X}_B \). The cost of continuing to investigate: \( \sum C_b = \beta_b (\mathcal{X}_B)^2 = \beta_b (\mathcal{X}_C - \mathcal{X}_B)^2 \). \( \beta_B > \lambda_B > 0 \) refers to the cost of commercial banks to continue to investigate the cost is greater than self-examination. In the same way, then third-party payment institution continues to investigate the cost of: \( \mathcal{X}_P = \mathcal{X}_C - \mathcal{X}_P \), that is: \( \sum C_p = \beta_p (\mathcal{X}_P)^2 = \beta_p (\mathcal{X}_C - \mathcal{X}_P)^2 \). \( \beta_P > \lambda_P > 0 \) refers to the cost of third party payment institution to continue to investigate the cost is greater than self-examination. Therefore, the total cost of anti-money laundering of commercial banks:

\[
\sum C_b = \sum C_b^1 + \sum C_b^2 = \lambda_b \mathcal{X}_B^2 + \beta_b (\mathcal{X}_C - \mathcal{X}_B)^2 + C_B
\]

After finishing:

\[
\sum C_b = \beta_b (\mu_b - \mu_B)^2 + \lambda_b \mu_b^2 \mathcal{X}_L^2 + C_B
\] (3)

Similarly, the total cost of anti-money laundering by third party payment agencies:

\[
\sum C_p = \sum C_p^1 + \sum C_p^2 = \lambda_p \mathcal{X}_P^2 + \beta_p (\mathcal{X}_C - \mathcal{X}_P)^2 + C_P
\]

After finishing:

\[
\sum C_p = \beta_p (\mu_p - \mu_P)^2 + \lambda_p \mu_p^2 \mathcal{X}_L^2 + C_P
\] (4)

**Hypothesis 3:** In the existing online payment business model, the main valuation methods are: fixed amount, fixed rate, subsection fee, etc. In order to facilitate the study, assuming that the payment agencies in accordance with the amount of transactions multiplied by the average rate of fees charged to the network merchants. Commercial banks also charge fees in accordance with this pricing strategy to the payment agency. Assuming that the average rate of commercial banks supply to third party payment institutions is \( R_B \), and the fee charged by the commercial bank to the third party payment institution is: \( R_B N \). The project is not only the income of commercial banks, but also the cost of the third party payment institutions. Assuming that the average rate of third party payment institutions to provide online payment services is \( R_P \). Only \( R_B > R_P \), third party payment institutions to gain profit, otherwise operating losses. The fee charged by third party payment institutions to the customer is: \( R_P N \), its income is: \( (R_B - R_P)N \). If commercial banks and third party payment institutions perform anti-money laundering obligations, then deductions from their income about the cost of self-examination. Therefore, After Self-examination, the utility function of commercial banks:

\[
F_B = R_B(N - \mathcal{X}_C) = R_B(N - \mu \mathcal{X}_L)
\] (5)

After Self-examination, the utility function of third party payment institutions:

\[
F_p = (R_p - R_B)(N - \mathcal{X}_C) = (R_p - R_B)(N - \mu \mathcal{X}_L)
\] (6)

According to (3) and (5) can be obtained, the case of unsupervised investigation, the utility function of the commercial bank:

\[
F_{WB} = F_B - \sum C_b = \{-\lambda_B \mu_B^2 + \beta_B (\mu_B - \mu_B)^2\} \mathcal{X}_L^2 - R_B \mu_B \mathcal{X}_L + R_B N - C_B
\] (7)

Similarly, according to (4) and (6) can be obtained, the case of unsupervised investigation, the utility function of third party payment institutions:

\[
F_{WP} = F_P - \sum C_p = \{-\lambda_P \mu_P^2 + \beta_P (\mu_P - \mu_P)^2\} \mathcal{X}_L^2 - (R_p - R_B) \mu_P \mathcal{X}_L + (R_p - R_B) N - C_P
\] (8)

**The Utility Function of Regulatory Agencies**

Regulatory agencies for commercial banks and Payment institutions can choose to investigate or not investigate.

**Hypothesis 4:** Assuming that the cost of anti-money laundering investigations by regulatory agencies: \( C_G \). Assuming that commercial banks and third party payment agencies take the initiative
to fight against money laundering for the cost savings for regulators: \( S_G = s\chi_L^2 = s\mu_2\chi_L^2 \), ( \( s > \lambda_b, s > \lambda_p \)). It shows that because the market report, then regulatory agencies to save the cost is greater than the cost of their own commitment, that the overall level of effectiveness can be improved.). Therefore, total cost of anti-money laundering by regulatory agencies.

\[
\sum C_G = C_G - S_G = C_G - s\mu_2\chi_L^2
\]

The state welfare loss caused by money laundering (the hazard rate of money laundering) is: \( \sigma \) ( \( \sigma \geq 0 \)). Because the market and regulatory agencies to investigate, can reduce the risk of money laundering. Therefore, the risk of money laundering is caused by the remaining money laundering amount, its expected value is:

\[
FD_L = \sigma (\chi_L - p\mu_1\chi_L - \mu_2\chi_L) = \sigma\chi_L(1 - p\mu_1 - \mu_2)
\]  \hspace{1cm} (10)

In addition, if commercial banks and third-party payment institutions do not fully fulfill the anti-money laundering obligations, then the regulatory authorities will be punished in accordance with the existing laws and regulations of China. Assuming that commercial banks are penalized probability of: \( L_p \). As can be seen from the above, the amount of money laundering directly investigated by regulatory authorities: \( \chi_G = \mu_1\chi_L \). Therefore, the total amount of commercial banks and third-party payment agencies are punished is:

\[
\sum L = pL_B\chi_G + pL_p\chi_G = p\mu_1\chi_L(L_B + L_p)
\]

According to (9), (10) and (11) can be obtained, the utility function of the country:

\[
FW_G = \sum L - (FD_L + \sum C_G) = s\mu_2\chi_L^2 + [-\sigma + p\mu_1(L_B + L_p + \sigma) + \sigma\mu_2]\chi_L - C_G
\]

According to (7) and (11) can be obtained, under the punishment of regulatory agencies, the utility function of commercial bank:

\[
FW_B = F_B - pL_B\chi_G - \sum C_B
\]

After finishing:

\[
FW_B = -[\lambda_B\mu_2^2 + \beta_B(\mu_2 - \mu_B)^2]\chi_L^2 - (R_B\mu_2 + pL_B\mu_1)\chi_L + R_BN - C_B
\]

According to (8) and (11) can be obtained, under the punishment of regulatory agencies, the utility function of third party payment institution:

\[
FW_p = F_p - pL_p\chi_G - \sum C_p
\]

After finishing:

\[
FW_p = -[\lambda_p\mu_2^2 + \beta_p(\mu_2 - \mu_p)^2]\chi_L^2 - [(R_p - R_B)\mu_2 + pL_p\mu_1]\chi_L + (R_p - R_B)N - C_p
\]

**Game Analysis of All Parties**

**Decision Analysis of Money Laundering People**

First order partial derivative of \( \chi_L \) in equation (2):

\[
\frac{\partial FW_L}{\partial \chi_L} = -2\beta_L\chi_L + [1 - p\mu_1 - \mu_2]
\]

Set the equation (15) = 0, and after solving:

\[
\chi_L^* = \frac{1 - p\mu_1 - \mu_2}{2\beta_L} > 0
\]

Because of \( \frac{\partial^2 FW_L}{\partial \chi_L^2} = -2\beta_L < 0 \), so \( \chi_L^* \) is optimal amount of money laundering for money laundering people.
When There Is No Regulatory Investigation, the Market Players Game Analysis

China’s online payment anti-money laundering self-examination and reporting work requires the joint efforts of commercial banks and third party payment agencies. Regulatory agencies transfer the report information from one side to the other side, in order to achieve full symmetry of information, and require them to carry out anti-money laundering investigation, in order to improve the efficiency of anti-money laundering. But if there is no regulatory investigation, it is easy to “free rider” behavior, thus affecting the effectiveness of anti-money laundering. As previously analyzed, commercial banks and third party payment agencies may take anti-money laundering or not anti-money laundering. \( \mu_b \) is the degree of active anti-money laundering by commercial banks. \( \mu_p \) is the degree of active anti-money laundering by third party payment agencies. \( \mu_z \) is the degree of active anti-money laundering by the market subject.

1. When commercial banks and third party payment agencies adopt anti-money laundering strategies, the utility function of commercial banks is:

\[
F_{WB} = -\lambda_b \mu_b^2 + \beta_b (\mu_z - \mu_b) \chi^2 - R_b \mu_z \chi + R_B N - C_B
\]

The utility function of third party payment agencies is:

\[
F_{WP} = -\lambda_p \mu_p^2 + \beta_p (\mu_z - \mu_p) \chi^2 - (R_p - R_B) \mu_z \chi + (R_p - R_B) N - C_p
\]

2. When the commercial bank adopts the strategy of not anti-money laundering, and the third-party payment institution adopts the anti-money laundering strategy. That is \( \mu_b = 0 \), \( \mu_z = \mu_p \); put \( \mu_b = 0 \) and \( \mu_z = \mu_p \) into (7), the utility function of commercial banks is:

\[
F_{WB} = -\lambda_b \mu_p^2 \chi^2 - R_b \mu_p \chi + R_B N - C_B
\]

Put \( \mu_b = 0 \) and \( \mu_z = \mu_p \) into (8), the utility function of third party payment agencies is:

\[
F_{WP} = -\lambda_p \mu_p^2 \chi^2 - (R_p - R_B) \mu_p \chi + (R_p - R_B) N - C_p
\]

3. When the commercial bank adopts the strategy of anti-money laundering, and the third party payment institution adopts the strategy of not anti-money laundering. That is \( \mu_p = 0 \), \( \mu_z = \mu_b \); put \( \mu_p = 0 \) and \( \mu_z = \mu_b \) into (7), the utility function of commercial banks is:

\[
F_{WB} = -\lambda_b \mu_b^2 \chi^2 - R_b \mu_b \chi + R_B N - C_B
\]

Put \( \mu_p = 0 \) and \( \mu_z = \mu_b \) into (8), the utility function of third party payment agencies is:

\[
F_{WP} = -\lambda_p \mu_b^2 \chi^2 - (R_p - R_B) \mu_b \chi + (R_p - R_B) N - C_p
\]

4. When commercial banks and third-party payment agencies adopt not money laundering strategy, that is \( \mu_z = \mu_b = \mu_p = 0 \); put \( \mu_z = \mu_b = \mu_p = 0 \) into (7), the utility function of commercial banks is:

\[
F_{WB} = R_B N - C_B
\]

Put \( \mu_z = \mu_b = \mu_p = 0 \) into (8), the utility function of third party payment agencies is:

\[
F_{WP} = (R_p - R_B) N - C_p
\]

According to the above, the optimal strategy of commercial banks and third-party payment institutions is 4 (Not anti-money laundering; Not anti-money laundering). Then both sides can get all the transaction related fee income, and do not assume any anti-money laundering costs, so that the anti-money laundering policy cannot be effectively implemented.

When There Are Regulatory Investigation, the Market Players Game Analysis

In order to ensure that the market subject to seriously implement the anti-money laundering policies, fulfill the obligation of anti-money laundering. Self-inspection report on money laundering. Regulatory agency need to investigate and deal with the behavior of the market players to conduct guidance and restraint, institutions that do not fully perform anti-money laundering
obligations will be punished. According to the above, assume \( \mu_1 = \delta_\mu - \mu_2 \). Combined with (13) and (14), after finishing, the utility function of the market players is obtained.

1. When commercial banks and third-party payment agencies adopt anti-money laundering strategies, the utility function of commercial banks is:

\[
F_{W_1} = \left[ \lambda_p \mu_p^2 + \beta_p (\mu_2 - \mu_B)^2 \right] \chi_L^2 - (R_B \mu_2 + pL_B \mu_1) \chi_L + R_B N - C_B
\]

The utility function of third party payment agencies is:

\[
F_{W_p} = \left[ \lambda_p \mu_p^2 + \beta_p (\mu_2 - \mu_B)^2 \right] \chi_L^2 - [(R_p - R_B) \mu_2 + pL_p \mu_1] \chi_L + (R_p - R_B) N - C_p
\]

2. When the commercial bank adopts the strategy of not anti-money laundering, and the third-party payment institution adopts the anti-money laundering strategy. That is \( \mu_B = 0 \), \( \mu_2 = \mu_p \);

Put \( \mu_B = 0 \) and \( \mu_2 = \mu_p \) into (13), the utility function of commercial banks is:

\[
F_{W_1} = \beta_p \mu_p^2 \chi_L^2 - [(R_B - pL_B) \mu_p + pL_B \delta_\mu \chi_L] + R_B N - C_B
\]

Put \( \mu_B = 0 \) and \( \mu_2 = \mu_p \) into (14), the utility function of third party payment agencies is:

\[
F_{W_p} = \lambda_p \mu_p^2 \chi_L^2 - [(R_p - R_B - pL_p) \mu_p + pL_p \delta_\mu \chi_L] + (R_p - R_B) N - C_p
\]

3. When the commercial bank adopts the strategy of anti-money laundering, and the third-party payment institution adopts the strategy of not anti-money laundering. That is \( \mu_p = 0 \), \( \mu_2 = \mu_B \);

Put \( \mu_p = 0 \) and \( \mu_2 = \mu_B \) into (13), the utility function of commercial banks is:

\[
F_{W_1} = R_B N - pL_B \delta_\mu \chi_L - C_B
\]

Put \( \mu_2 = \mu_B = \mu_p = 0 \) into (14), the utility function of third party payment agencies is:

\[
F_{W_p} = (R_p - R_B) N - pL_p \delta_\mu \chi_L - C_p
\]

From above, if the regulatory authorities to investigate and deal with the mechanism is effective, when the commercial banks to take anti-money laundering strategy, if the effectiveness of the third party payment agencies to adopt anti-money laundering strategy is greater than the effectiveness of not anti-money laundering strategy, then the third party payment agencies choose anti-money laundering strategy. Similarly, when the third party payment agencies do not take anti-money laundering strategy, commercial banks will choose anti-money laundering strategy. So get:

\[
-\lambda_p \mu_p^2 \chi_L^2 - \chi_L [(R_p - R_B - pL_p) \mu_p + pL_p \delta_\mu] + (R_p - R_B) N - C_p \geq (R_p - R_B) N
\]

After simplification:

\[
L_p \geq \frac{1}{\beta} (\lambda_p \mu_p \chi_L + R_p - R_B)
\]

\[
L_p \geq \frac{1}{\beta} (\lambda_B \mu_B \chi_L + R_B)
\]

We can see from above, (16) and (17) refers to that regulatory agencies to commercial banks and third party payment agencies to reach or exceed a certain level of punishment, which will effectively promote the market players to actively implement the anti-money laundering duties.

**Strategic Analysis of Regulatory Agencies**

First order partial derivative of \( \sigma \) in (12), the results are as follows:
\[
\frac{\partial F_{W_L}}{\partial \sigma} = -(1-p\mu_i - \mu_2)\chi_L < 0
\]

This shows that the greater the rate of money laundering, the smaller the regulatory agencies’ utility function.

First order partial derivative of \( \mu_1 \) in (12), the results are as follows:

\[
\frac{\partial F_{W_L}}{\partial \mu_1} = p(L_h + L_p + \sigma)\chi_L > 0
\]

This shows that the greater the intensity of the initiative to investigate the regulatory authorities, the greater the regulatory agencies’ utility function.

First order partial derivative of \( \mu_2 \) in (12), the results are as follows:

\[
\frac{\partial F_{W_L}}{\partial \mu_2} = 2s\mu_2\chi_L^2 + \sigma\chi_L > 0
\]

This shows that the greater the intensity of self-examination of the market, the greater the regulatory agencies’ utility function.

**Conclusion**

According to the results of this study, we propose the following suggestions.

1. Regulatory agencies should increase the intensity of the investigation of cyber money laundering, which can effectively reduce the amount of money laundering and curb money laundering activities. To improve the efficiency of anti-money laundering regulatory authorities, increase the cost of anti-money laundering by the regulatory agencies, and increase the proportion of money laundering punishment, can effectively reduce the amount of money laundering, so as to curb the crime of money laundering activities.

2. Regulatory agencies to guide commercial banks and third-party payment agencies to actively implement the relevant laws and regulations on anti-money laundering, establish and improve the internal control system of anti-money laundering financing. Monitor and analyze the transaction process, timely report large and suspicious transaction information.

3. Crack down on money laundering crime. The greater the harm of money laundering, the greater the loss of social welfare. In the case of money laundering which causes great harm to the society, it is necessary to improve the probability of money laundering investigation, and to develop a more stringent money laundering punishment policy in order to reduce the loss of social welfare.

4. Regulatory agencies should focus on the relationship between financial institutions and non-financial institutions in online payments. And can accurately identify the new mode of network payment and funds transfer path of money laundering. Improve the comprehensive cost of money laundering. Strengthen the supervision and management of the main market, cannot fully fulfill the anti-money laundering obligations or in violation of the relevant anti-money laundering law of the main market subject to strict punishment, to prevent the emergence of “free rider”.

**Reference**


