Game Analysis on Government Subsidy for Agricultural Enterprise’ IoT Investment

Na Fu, Xirui Zhang, Zhidan Jia
Tianjin Agricultural University, Tianjin, China, 300381
Corresponding author’s e-mail: Na Fu, scarlett_fn@126.com

Abstract: There are many problems in the production and circulation of agricultural products. Internet of Things (IoT) can improve these issues. But it is difficult for a single agribusiness to bear the huge IoT investment alone, and the government needs to give certain subsidy. However, the amounts and conditions of subsidy are a series of difficult choices faced by the government. This paper will use the incomplete information game to analyse the above problems and make relevant suggestions.

1. Introduction
At present, there are two main problems in agricultural product supply chain. Firstly, the post-harvest loss is serious. Secondly, food safety is difficult to guarantee. With the development of IoT technology, it began to apply into the field of agricultural product supply chain. It can not only realize the seamless connection between upstream and downstream enterprises through product real-time tracking technology, greatly improve transportation efficiency, reduce circulation corruption rate and save cost. It also can establish product traceability system, clarify the responsibility of each participant, and ensure the safety of agricultural products. But the application of the IoT is bound to increase the cost of input, and because the agricultural products have the characteristics of long production cycle, perishable, and large post-harvest losses. The investment in agriculture-related fields is characterized by high risks and low returns. Even the large enterprises are not willing to make large-scale investments, it will further restrict the development of agricultural and forming a vicious circle. In order to improve the construction of agricultural infrastructure and increase the revenue of farmers, the government should give certain support.

However, due to asymmetric information, whether the enterprises will work hard after receiving the government subsidy. How many subsidies can really stimulate the efficiency of agricultural enterprises? This paper will analyze the above problems through incomplete information game.

2. Literature review
2.1. Application of IoT in agricultural product supply chain
IoT was first proposed by Professor Ashton of the Massachusetts Institute of Technology (MIT) in 1999. At that time, it only referred to intelligent identification technology based on Radio Frequency Identification (RFID) technology [1]. In 2005, the International Telecommunication Union (ITU) officially proposed the concept of IoT, expanded the meaning and coverage of IoT, and defined the IoT as a network that intelligently identifies, locates, tracks, monitors and manages [2].
At present, the research on the application of the IoT in the agricultural product supply chain is mostly carried out around RFID technology. Mangina and Vlachos (2005)\(^3\) showed that RFID can effectively reduce product recalls and inventory, improve communication, and achieve chain coordination. Regattieri et al. (2007)\(^4\) compared the relative advantages and disadvantages of barcode technology and RFID technology, the specific application mode of RFID in agricultural product traceability system is analyzed. Li (2011)\(^5\) believed that the establishment of traceability system is essential for the green agricultural products supply chain management, as the IoT provides technical support for the establishment of traceability systems and represents the future direction of information agriculture development.

2.2. Government subsidy
The study of government financial subsidy originated from Pigou’s, he believed that no matter whether the external economy or the external uneconomic causes the social welfare to be maximized, governments can intervene by means of “extra rewards” (subsidy) or “extra restrictions” (taxes)\(^6\). Baibing (1995)\(^7\) discovered that the government can guide the production behavior of enterprises by adjusting the tax rate. Baoyin et al. (2006)\(^8\) discovered that if the enterprise's efforts in business management can improve the economic environment, the government should appropriately increase subsidy, improve the operational efficiency of enterprises and maximize social welfare, so as to achieve a win-win situation. Girma et al. (2008)\(^9\) took Ireland as an example, found that government subsidies are effective in overcoming corporate financial crisis and actively adopting new technologies. Klette et al. (2010)\(^10\) examines the effectiveness of government-funded commercial R&D and demonstrates whether government subsidy can encourage companies to choose projects that they do not actively choose to invest with high social returns.

In summary, the research on the IoT mostly stays in the product traceability systems, and there is relatively little research on whether IoT should be invested. The research on government subsidy mainly focuses on whether the government should provide subsidy and the role of subsidy. There are relatively few studies on the game behaviors of government and enterprises around subsidy. Therefore, this paper will use the incomplete information game model to study the interaction between government and enterprises, and provide evidence for the government to formulate relevant subsidy policies and how enterprises can better obtain government subsidy to achieve a win-win situation.

3. Basic game model constructions

3.1. Meaning of model related parameters
Through the paper, the first letter of superscripts \(h\) and \(l\) denote the high and low subsidy respectively. The second letter of super scripts \(s\) and \(l\) denote the effort and lazy strategy respectively. The subscript \(g\) and \(f\) denote the government and agricultural enterprise respectively. The meanings of the other notation are shown in Table 1.

| letter | meaning                        | letter | meaning               |
|--------|--------------------------------|--------|-----------------------|
| \(p_b\) | probability of natural selection | \(R\)  | Agricultural Enterprise’ revenue |
| \(c_h\) | the operating cost of choose effort | \(H\)  | government high subsidy |
| \(c_l\) | the operating cost of choose lazy | \(L\)  | government low subsidy |

3.2. Basic settings of the model
The game process is that the agricultural enterprise formulates an IoT investment plan and applies for government subsidy. The government decides whether to grant subsidy to enterprise according to the investment plan and forecast of whether the enterprise will work hard after obtaining subsidy. At the same time, the government decides give high or low subsidy to agricultural enterprise. Enterprise invests IoT after receiving subsidy. The government cannot effectively monitor whether the enterprise
operate effort or not, and also cannot control the impact of nature on agricultural output. Therefore, this paper makes the following basic assumptions for the model.

1) Game participants

There are two participants in our game model, the government and agricultural enterprise.

2) Strategy space

The government’s strategic space includes three options: no subsidy, high subsidy and low subsidy. The agricultural enterprise’s strategic space includes not investing IoT, investing IoT with effort and investing IoT with lazy. Efforts means that the enterprise invests all funds into the construction of the IoT in accordance with government requirements, comprehensively supervises the production process, and effectively promotes and promotes the products.

3) Cost and benefit analysis

① Cost analysis

The government is not responsible for specific production and operation, and subsidy is its cost. When the government chooses high subsidy, cost is $H$; when the government chooses low subsidy, cost is $L$; and $H > L$.

For agricultural enterprise, besides investing in IoT, it is also responsible for the business activities such as the R&D and promotion of products, the supervision and management, and other business activities. The operating cost is an increasing function of the effort level, that is, the harder the enterprise works, the higher the operating cost is. When an agricultural enterprise work hard, its cost is $c_h$; when it lazy, the cost is $c_l$; where $c_h > c_l$.

② Revenue analysis

High government subsidy will encourage enterprise to purchase better IoT equipment, optimize operational efficiency, and optimize production. When the government chooses low subsidy, the enterprise's IoT investment is relatively small. Insufficient input of the IoT itself will bring losses. Therefore, the final revenue of the government and enterprise is affected by the choice of government subsidy strategy, the degree of corporate efforts and natural conditions.

The government's choice of high subsidy, enterprise select efforts, and good natural conditions are the best state standards. At this time, the enterprise's revenue is $R$.

First, assume the other conditions are the same, when the government chooses low subsidy, compare with the high subsidy, the IoT configuration is insufficient, so the revenue is $\gamma$ times the high subsidy,$(1 - \gamma)$ represents the loss rate of insufficient IoT configuration.

Second, other conditions remain unchanged. When the enterprise chooses lazy, the enterprise’s revenue is $\alpha R$, $(1 - \alpha)$ is the loss rate of revenue caused by the enterprise’s laziness.

Finally, other conditions remain unchanged, natural conditions are poor, and enterprise revenue is $\beta R$. $(1 - \beta)$ is the loss rate of revenue caused by natural environment such as disasters.

Where, $0 < \gamma < 1$, $0 < \alpha < 1$, $0 < \beta < 1$.

When the government does not subsidize, if enterprise still choose IoT investment, due to the financial affordability limit, enterprise will only purchase the maximum number of IoT under the government's low subsidy. Since the enterprise bears a large investment cost alone, the enterprise will definitely choose to work hard. Then the profit of the enterprise is,

$$\Pi_f = p_b(1-t)(\gamma R - c_h) + (1-p_b)(1-t)(\beta \gamma R - c_h) = (1-t)(\gamma(p_b + (1-p_b)\beta)R - c_h)$$

If $1 - p_b < \frac{\gamma R - c_h}{(1-\beta)\gamma R}$, the probability of selection of natural conditions is greater than a certain value, that is, agricultural enterprise is faced with greater risk uncertainty, $\Pi_f^d < 0$, it is reluctant to invest. Therefore, when the government does not subsidize, the agricultural enterprise will not invest the IoT, the profits of both parties are 0.

④ Profit distribution

The government's income is that more residents have obtained better quality agricultural products and improved people's material living standards. At the same time, it can raise taxes from the increased profits of enterprise and reuse them for public utilities. For better quantification, this article only considers the tax portion as the government's income, and the tax rate is $t$. 
For the consistency of expression, our paper use government profit denotes the government net income. So, government profits \( \Pi_g = t \) (enterprise revenue-enterprise cost). The profit of the agricultural enterprise is \( \Pi_f = (1-t)(\text{enterprise revenue-enterprise cost}) + \) government subsidy.

4. Model analysis and strategy selection

4.1. Both participants expect profit

According to the previous description of the model, we can get the expected profit of both participants of the game under different circumstances.

1) When the government chooses high subsidy and the enterprise chooses effort

\[
\Pi_g^{hs} = p_b \left( t(R - c_h) - H \right) + (1 - p_b) \left( t(\beta R - c_h) - H \right)
\]

2) When the government chooses high subsidy and the enterprise chooses lazy

\[
\Pi_g^{hl} = p_b \left( t(\alpha R - c_l) - H \right) + (1 - p_b) \left( t(\alpha \beta R - c_l) - H \right)
\]

3) When the government chooses low subsidy and the enterprise chooses effort

\[
\Pi_g^{ls} = p_b \left( t(\gamma R - c_h) - L \right) + (1 - p_b) \left( t(\gamma \beta R - c_h) - L \right)
\]

4) When the government chooses low subsidy and the enterprise chooses lazy

\[
\Pi_g^{ll} = p_b \left( (1-t)(\gamma R - c_h) + L \right) + (1 - p_b) \left( (1-t)(\gamma \beta R - c_h) + L \right)
\]

4.2. Analysis of strategic choices between the two parties

Since our paper adopts the assumption of sequential game, the solution is reversed, the enterprise’s strategy choice is analyzed first, and then the government’s strategy choice is analyzed.

1) Strategic choice of agricultural enterprise under high government subsidy

According to analysis, the formula (2)-(4) indicates that when the government chooses high subsidy, the expected profit difference between the agricultural enterprise’s choice of effort and lazy is,

\[
\Delta \Pi_f^h = \Pi_f^{hs} - \Pi_f^{hl} = (1 - t)(1 - \alpha)(p_b + (1 - p_b)\beta)R - (c_h - c_l)
\]

The condition for ensuring agricultural enterprise to work hard is \( \Delta \Pi_f^h > 0 \).

By assuming

\[
A_1 = ((p_b + (1 - p_b)\beta)R - c_h) - (\alpha(p_b + (1 - p_b)\beta)R - c_l)
\]

Therefore, under the condition of government choosing high subsidy, when \( A_1 > 0 \), the optimal strategy of the agricultural enterprise is effort; otherwise, when \( A_1 < 0 \), the optimal strategy is lazy.

2) Strategic choice of agricultural enterprise under low government subsidy

According to the analysis, the formula (6)-(8) indicates that when the government chooses low subsidy, the expected profit difference between the agricultural enterprise’s choice of effort and lazy is,

\[
\Delta \Pi_f^l = \Pi_f^{ls} - \Pi_f^{ll} = (1 - t)(1 - \alpha)(\gamma(p_b + (1 - p_b)\beta)R - (c_h - c_l))
\]

The condition for ensuring agricultural enterprise to work hard is \( \Delta \Pi_f^l > 0 \).

By assuming

\[
A_2 = (\gamma(p_b + (1 - p_b)\beta)R - c_h) - (\alpha \gamma(p_b + (1 - p_b)\beta)R - c_l)
\]

Therefore, under the condition of the government choosing low subsidy, when \( A_2 > 0 \), the optimal strategy of the agricultural enterprise is effort; on the contrary, when \( A_2 < 0 \), the optimal strategy is lazy.

Comparing \( 1 \) and \( 2 \),

\[
A_1 - A_2 = (1 - \alpha)(1 - \gamma)(\beta + (1 - \beta)p_b)R > 0
\]
So, obtain proposition 1.

Proposition 1: \( A_1 > A_2; \) when \( A_1 > 0, \Delta \Pi_h > 0; \) when \( A_2 > 0, \Delta \Pi_l > 0. \)

Proposition 1 shows that whether the government chooses high or low subsidy, when the expected profit of effort is greater than the lazy, the optimal strategy of the agricultural enterprise is to work hard. On the contrary, the optimal strategy is lazy. Simultaneously \( A_1 > A_2, \) shows that the conditions for agricultural enterprise to choose to effort are different between the government’s high and low subsidy. Making a deformation of \( A_1 \) and \( A_2 \) to get lemma 1 and lemma 2.

Lemma 1:
(i) When \( A_1 > 0, \Delta \Pi_h \) is a reduction function of \( t; \) \( A_2 > 0, \Delta \Pi_l \) is a reduction function of \( t. \)
(ii) \( \Delta \Pi_h \) and \( \Delta \Pi_l \) are reduction functions of \( \alpha \) respectively.
(iii) When \( \gamma > \frac{c_l-c_h}{(1-\alpha)[p_h+(1-p_h)]R}, \) \( \Delta \Pi_h > 0, \) and \( \Delta \Pi_l \) is an increment function of \( \gamma. \)

Lemma 1(i) shows that no matter what the government chooses, the government tax ratio \( t \) is smaller, the greater the profit difference between the enterprise’s effort and lazy. The more profit that the enterprise strives to gain, the more it is willing to choose to effort.

Lemma 1(ii) shows that the smaller \( \alpha \) is, the bigger \( (1-\alpha) \) is, that is, the greater loss rate of lazy, the enterprise is more willing to choose effort.

Lemma 1(iii) shows that when the government adopts low subsidy strategy, only when the revenue loss rate brought by the low subsidy strategy to the agricultural enterprise is less than a certain value, it is willing to choose effort strategy. Because when the loss of revenue caused by insufficient IoT investment is large, even if the enterprise is hard to operate, it is difficult to make up for the losses caused by insufficient IoT investment, the agricultural enterprise is not willing to choose effort.

Further, let \( c_h \) represent the threshold value of the effort cost which the agricultural enterprise chooses to work hard under high subsidy strategy. \( c_l \) represents the threshold value of the effort cost which the enterprise chooses to work hard under the government’s low subsidy. \( (1-\alpha_h) \) represents the threshold value of the lazy loss rate required by which enterprise chooses to work hard under the government’s high subsidy. \( (1-\alpha_l) \) represents the threshold value of the lazy loss rate which the enterprise chooses to work hard under the government’s low subsidy, lemma 2 can be obtained.

Lemma 2:
(i) \( c_h > c_l \)
(ii) \( (1-\alpha_h) < (1-\alpha_l) \)

Lemma 2(i) shows that the threshold condition of effort under the high subsidy strategy is higher than the low subsidy. Because the government’s high subsidy can enable agricultural enterprise to invest more IoT than low subsidy, resulting in higher revenue improvements than low subsidy. At this time, enterprise is willing to accept higher efforts cost and choose to work harder. Corresponding, in the case of low subsidy, because the low subsidy makes the enterprise’s revenue improvement relatively small, the enterprise is willing to work hard only when the effort cost is lower.

Lemma 2(ii) shows that, compared with the high subsidy strategy, the agricultural enterprise is willing to choose to work hard only when the low subsidy strategy lead to a greater laziness loss rate. Because low subsidy brings less benefit to the enterprise than the benefits of high subsidy, to make the enterprise to choose effort, it need that effort can avoid greater losses.

(2) Government expectation of profit and strategy analysis

Does the government choose subsidy

According to the previous analysis, lemma 3 can be obtained.

Lemma 3:
When \( t > \frac{H}{L[(1-p_h)\beta+p_h]-c_h], \) \( \Pi_h > 0; \) when \( t > \frac{H}{(aH(1-p_h)\beta+p_h)-c_l]} \), \( \Pi_l > 0; \) when \( t > \frac{L}{yR[(1-p_h)\beta+p_h]-c_h]}, \) \( \Pi_h > 0; \) when \( t > \frac{L}{yR[(1-p_h)\beta+p_h]-c_l]}, \) \( \Pi_l > 0. \)
Lemma 3 explains that no matter whether the agricultural enterprise chooses effort or lazy, when the tax rate \( t \) is greater than a certain level, the government will choose a subsidy strategy to encourage agricultural enterprise to invest IoT for the benefit of the whole society.

(2) Does the government choose high subsidy or low subsidy

First, consider the government's optimal strategy choice when the agricultural enterprise chooses the effort strategy. According to the previous analysis, the formula (1)-(5) is equal to the profit difference between the government's choice of high and low subsidy when the agricultural enterprise chooses effort.

\[
\Delta \Pi_g^e = \Pi_g^{hs} - \Pi_g^{ls} = (t(p_b + (1 - p_b)\beta)R - H) - (t(p_b + (1 - p_b)\beta)\gamma R - L)
\]

By assuming

\[
B_1 = (t(p_b + (1 - p_b)\beta)R - H) - (t(p_b + (1 - p_b)\beta)\gamma R - L)
\]

Therefore, under the premise of efforts strategy, when \( B_1 > 0 \), the government's optimal strategy is high subsidy. On the contrary, when \( B_1 < 0 \), the government's optimal strategy is low subsidy.

Second, when agricultural enterprise chooses the lazy strategy, the government chooses the best strategy. According to the previous analysis, the formula (3)-(7) is equal to the profit difference between the government's choice of high and low subsidy strategy when the agricultural enterprise chooses lazy.

\[
\Delta \Pi_g^l = \Pi_g^{hl} - \Pi_g^{ml} = (t(p_b + (1 - p_b)\beta)\alpha R - H) - (t(p_b + (1 - p_b)\beta)\gamma\alpha R - L)
\]

By assuming

\[
B_2 = (t(p_b + (1 - p_b)\beta)\alpha R - H) - (t(p_b + (1 - p_b)\beta)\gamma\alpha R - L)
\]

Under the premise of lazy strategy, when \( B_2 > 0 \), the government's optimal strategy is high subsidy. On the contrary, when \( B_2 < 0 \), the government's optimal strategy is low subsidy. Therefore, proposition 2 can be obtained.

**Proposition 2:** When \( B_1 > 0 \), \( \Delta \Pi_g^e > 0 \); when\( B_2 > 0 \), \( \Delta \Pi_g^l > 0 \).

Proposition 2 shows that no matter whether the agricultural enterprise chooses effort or lazy, the government is willing to choose the strategy of high subsidy when the expected profit brought by high subsidy is higher than low subsidy. Deform the inequality in Proposition 2, get lemma 4 and lemma 5.

**Lemma 4:**

(i) When \( \gamma > \frac{(H-L)}{\alpha(1-\gamma)(1-p_b)\beta+p_b}R \), \( \Delta \Pi_g^e > 0 \); when \( t > \frac{(H-L)}{(1-\gamma)(1-p_b)\beta+p_b}R \), \( \Delta \Pi_g^l > 0 \); \( \Delta \Pi_g^e \) and \( \Delta \Pi_g^l \) are the increasing functions of \( t \) respectively.

(ii) When \( \gamma < 1 - \frac{(H-L)}{\alpha(1-\gamma)(1-p_b)\beta+p_b}R \), \( \Delta \Pi_g^e > 0 \); when \( \gamma < 1 - \frac{(H-L)}{\alpha(1-\gamma)(1-p_b)\beta+p_b}R \), \( \Delta \Pi_g^l > 0 \); \( \Delta \Pi_g^e \) and \( \Delta \Pi_g^l \) both are the decreasing functions of \( \gamma \).

(iii) When \( \alpha > \frac{(H-L)}{(1-\gamma)(1-p_b)\beta+p_b}R \), \( \Delta \Pi_g^e > 0 \); \( \Delta \Pi_g^e \) and \( \Delta \Pi_g^l \) both are reduction functions of \( \alpha \).

Lemma 4(i) explains that no matter what the enterprise chooses effort or lazy, the government is willing to choose a high subsidy strategy only when the tax rate \( t \) is greater than a certain value. And the greater tax ratio \( t \) is, the more the government is willing to choose a high subsidy strategy.

Simultaneously, due to \( 0 < \alpha < 1 \), lemma 4(ii) also show that the conditions for the government to adopt a high subsidy strategy will become stricter when agricultural enterprise chooses a lazy strategy, because enterprise’ lazy strategies will cause a decline in government revenue. At this time, only a higher tax rate can make up for the losses caused by the enterprise’s lazy strategy. But according to lemma 1(i), no matter whether the government chooses high or low subsidy, the greater the government's tax ratio \( t \), the more companies are willing to choose lazy business. Thus, the tax ratio \( t \) is a very important variable. Therefore, when formulating the tax ratio, the government must consider its own profitability and the ability of the enterprise to bear.

Lemma 4(ii) shows that no matter what strategy the agricultural enterprise chooses, only when the loss rate brought by the government's low subsidy is greater than a certain value, the government is willing to choose a high subsidy strategy. When \( \gamma \) is smaller, the \((1-\gamma)\) is larger, the greater revenue loss caused by insufficient IoT investment is, the more the government is willing to choose a
The high subsidy strategy. Simultaneously lemma 4(ii) also shows that when companies choose a lazy strategy, the government’s choice of a high-subsidy strategy becomes more stringent, and the government is willing to adopt a high-subsidy strategy only when low subsidy bring greater losses.

Lemma 4(iii) shows that when an agribusiness chooses a lazy strategy, the government is willing to choose a high subsidy strategy only when the loss rate caused by lazy is less than a certain value. The larger $\alpha$ is, the smaller $(1 - \alpha)$ is, the smaller the lazy loss rate is, the higher the government’s willingness to choose a high subsidy strategy.

Further, deform the proposition 2, by assuming $C_1 = (1 - \gamma)t((1 - p_b)\beta + p_b)R$, represent the expected profit loss caused by the government choosing low subsidy when agricultural enterprise chooses effort strategy. By assuming $C_2 = (1 - \gamma)t((1 - p_b)\beta + p_b)\alpha R$, represent the expected loss of profits caused by the low subsidy when enterprise choose lazy, lemma 5 can be obtained.

**Lemma 5:** $C_1 > C_2$, when $C_1 > H - L, \Delta \Pi_1^g > 0$; when $C_2 > H - L, \Delta \Pi_2^l > 0$.

According to lemma 5, regardless of whether the agricultural enterprise is striving to operate, when the government expects the loss of profits caused by low subsidy is greater than the difference between high subsidy and low subsidy, the government will adopt a high subsidy strategy. At the same time, when the agricultural enterprise chooses to work hard, the government is willing to adopt a high subsidy strategy only when the government’s low subsidy expects loss is larger, because the effort can increase the government’s profits, so the incentives for the government to adopt the high subsidy strategy become smaller. In addition, lemma 5 also shows that when the difference between high and low subsidy increases, the conditions for the government to adopt a high subsidy strategy will become stricter. That is, when the government formulates the subsidy strategy, the greater the difference between the governments’ high and low subsidy, the more cautious the government will when he adopts the high subsidy strategy.

5. Countermeasures for accelerating the development of agricultural industry

**5.1. The government should increase subsidy to promote agricultural IoT investment**

Through the model analysis, when the government provides subsidy to the agricultural enterprise to support its IoT investment, it will not only improve the profits of agricultural enterprise, but also bring better quality agricultural products to consumers. It can improve the consumption level of agricultural products in the whole society, reduce the rate of product loss and improve the economic benefits of the society. Therefore, the government should actively support agricultural enterprise to invest the IoT, but such support should not be blind and unconditional. The government should support those enterprises that have certain economic strength, and are willing to work hard, so as to gradually form an agricultural industrial system with high efficiency and high quality of service.

**5.2. Agricultural enterprises should operate in good faith and strengthen cooperation**

Through the analysis of the model, if the agricultural enterprises do not work hard, they will reduce the government’s willingness to subsidize, and finally lead to zero revenue. Therefore, the agricultural enterprises should operate in good faith, continuously improve the quality of agricultural products, reduce the rate of product decay, and attracting more subsidies from the government. At the same time, agricultural enterprises can also strengthen cooperation, form industrial clusters, realize scale operations, strengthen the competition of the entire industrial cluster, and negotiate with the government in the form of industrial groups to enhance the bargaining power.

**5.3. Establish a variety of investment mechanisms to provide support for agricultural development**

Finance is the core of modern economy and plays an important role in guiding the allocation of resources, regulating economic operation and serving the economy and society. The rapid development of agricultural products cannot be separated from the support of finance. It is difficult to produce high-quality agricultural products without sufficient capital. Therefore, to strengthen the development of agricultural industry, it is necessary to have sufficient capital input. If the source of
funds only depends on the government, it is difficult to solve the funding problem of agricultural industry development in a short time, and it will increase the financial risk of the government. Therefore, if want to develop agricultural industry rapidly and healthily, should establish diversified investment and financing mechanism, effectively solve the problem of financing difficulty of agricultural industry, and introduce risk avoidance mechanism to reduce the operation risk of agricultural enterprises. For example, accelerate efforts to put the IoT related products and equipment into the catalogue of subsidies for agricultural machinery purchase, so as to encourage social forces, such as telecom operators, IT enterprises and scientific research institutes to invest in the construction of the agricultural IoT, and gradually form the diversification of investment subjects under the guidance of the government, maintain market-oriented operation, and jointly promote the development of the agricultural IoT.

6. Conclusions
Based on the incomplete information game model, this paper makes an analysis on whether the government should subsidize IoT investment of the agricultural enterprises and how the enterprises should do to better attract government subsidy. It is found that whether agricultural enterprises choose to work hard or not, they all hope the government to provide subsidy. However, the possibility of the government to provide high subsidy increases with the increase of the probability of the enterprise to work hard. When the gap between high and low subsidy becomes larger, the conditions for the government to choose high subsidy will be stricter. At the same time, the tax proportion $t$ is also a very important factor to determine the strategic choice of both participants, it directly affects the level of government subsidy and whether agricultural enterprises work hard or not. Therefore, when determining $t$, not only considering the government profit, but also considering the bearing limit of agricultural enterprises.

This paper does not discuss the possibility of repeated games, and does not add punishment measures to the consequences of lazy strategy of agricultural enterprises, but only assumes that lazy will reduce the final revenue. If the cost of government supervision and penalties for laziness are included, the strategic choice of both sides may change, which needs to be studied in the future.

Acknowledgments
This research was supported by the Tianjin Philosophy and Social Science Planning Project “Research on Agricultural IoT Investment and Government Subsidy under the Background of Beijing-Tianjin-Hebei Collaborative Development” (TJGL17-021) and Tianjin Science and Technology Development Strategy Research Project (18ZLZXZF00470) "The research on ‘1+N’ agricultural financial mode innovation based on IoT technology”.

References
[1] Sarma S., Brock D.L. (2000) The networked physical world. Auto-ID Center White Paper MIT-AUTOID-WH-001.
[2] International Telecommunication Union. (2005) ITU Internet Reports: The IoT. Geneva: ITU.
[3] Mangina E., Vlachos I. P. (2005) The changing role of information technology in food and beverage logistics management: beverage network optimisation using intelligent agent technology. Journal of Food Engineering, 70(3): 403-420.
[4] Regattieri A., Gamberti M., Manzini R. (2008) Traceability of food products: General framework and experimental evidence, Journal of Food Engineering,11(2):347-356.
[5] Li L. Application of the internet of thing in green agricultural products supply chain management. The Fourth Conference on Intelligent Computation Technology and Automation. IEEE, pp.1022-1025.
[6] Pigou A.C. (2013) The economics of welfare. Palgrave Macmillan.
[7] Baibing L. (1995) Taxation, Subsidy and Output Levels of Firms. Journal of Beijing Institute of Technology,15(1):29-33.
[8] Bao-Yin Z., Bo W., Yu W.U. (2006) Incentive and Monitor Problems of Government Based on Cycle Economy Pattern. Chinese Journal of Management Science, 14(1):136-141.

[9] Girma S, Görg H, Strobl E, et al. (2008) Creating jobs through public subsidy: An empirical analysis. Labour economics, 15(6): 1179-1199.

[10] Klette T J, Moen J, Griliches Z. (2000) Do subsidy to commercial R&D reduce market failures? Microeconometric evaluation studies, Research Policy, 29(4): 471-495.