Incentive Mechanism Model Design for Sharing of Information Resources in Rural Areas

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Abstract In order to solve the issues concerning the cross-unit sharing of information resources in rural areas, we analyze the incentive problem of the sharing of information resources in rural areas using the incentive theory method; establish corresponding incentive mechanism model (It is divided into positive incentive model and negative incentive model, and only when the two models guarantee each other and are used at the same time can they be effective). Based on this, we put forward the institutional design for sharing of information resources in rural areas as follows: firstly, establishing an administrative agency of rural information resources sharing, above the authority of all units, responsible for related work on sharing of information resources in rural areas; secondly, establishing and improving the positive and negative incentive mechanisms, to ensure the realization of sharing of information resources in rural areas.

Key words Rural information resources, Information sharing, Propulsion mechanism, Incentive model

The sharing of information resources in rural areas is an important way to achieve rural informatization and coordinated urban-rural development. The collection and provision subject of rural information resources includes government departments, non-governmental public service organizations, and private organizations. Government departments mainly provide weather information, soil information, pest control, migrant workers' employment information, farmers' livelihood security information, national rural policy information, and the basic information closely related to issues concerning agriculture, countryside and farmers; non-governmental public service organizations mainly include science and technology institutes, all junior and regular colleges, agricultural technology promotion stations, *etc.*, which provide agricultural technology information and agricultural development information for rural areas; private organizations include agricultural enterprises, supermarkets, farmers' markets, *etc.*, which can provide considerable information on procurement and sale of agricultural products. All production units of rural information resources view information as a symbol of the power, and they have too much control over the right to the information, making the people who really need the rural information resources fail to obtain valid information, resulting in inefficient utilization of rural information resources[1]. The sharing of information resources in rural areas can precisely resolve this prominent contradiction of information access, so that the rural information resources can be effectively processed and utilized, to better serve the rural areas, agriculture and farmers' living.

China's scholars have already carried out some researches on rural informatization and sharing of information resources in rural areas. Gao Yongmin conducts field survey on rural information construction in Qingyang City, and studies the role of informatization in rural economy and society, believing that the rapid development of rural informatization has broken the previous remoteness and closeness of rural areas, promoted farmers' ability to obtain information, enriched rich spiritual and cultural life in rural areas, improved the quality of the majority of farmers, greatly propelled the process of increase in farmers' income and agricultural industrialization, promoted the development of rural tertiary industry and the dissemination of information of weather forecasting and natural disaster prediction, and also played a very active role in ensuring the safety of agricultural production and rural disaster prevention and mitigation[2]. The premise of realizing informatization in rural areas is to achieve sharing of information resources among all relevant rural units, improve the efficiency of society and achieve rural informatization by sharing. Wang Lijun, *et al.*, believe that advancing informatization is an important way to accelerate the building of a harmonious society, but one of the biggest barriers we may encounter in the process of advancing informatization in rural areas is information sharing[3]. Liu Dan mentions that with increasingly deepening process of informatization in urban areas, the demand for the sharing of information resources is increasingly huge[4]. Ma Feicheng establishes the information sharing model, analyzes the reason for the changes in the welfare and efficiency losses in the process of information sharing, and based on this, puts forth the efficiency improvement programs and reasonable measures for sharing of information resources[5].

Based on previous studies, we establish the theoretical incentive model of cross-unit sharing of information resources in rural areas using incentive theory method, and conduct a systematic analysis of the incentive strategy for sharing of information resources in rural areas, in order to effectively induce the units in society to participate in the work of sharing of information resources in rural areas, thereby promoting the continuous development of informatization in rural areas.

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1 Rural information sharing environment and assumptions

1.1 Environment

1.1.1 Social environment. The integration of urban and rural ar-

eas is incessantly deepened, the rural economy rises rapidly, and the modernization degree of rural production mode and lifestyle is continuously improved, therefore, the rural residents pose higher requirements on the informatization.

1.1.2 Information environment. The legal system of electronic information is gradually established and improved, the level of information-based technology is increasingly high, and the informatization in urban areas begins to take shape, but the level of informatization in rural areas is relatively low.

1.1.3 Internal environment of units providing information related to agriculture. There is a parallel relationship between the units which provide agriculture-related information, difficult to form the matrix-style organizational structure with government as leading units.

1.2 Assumptions

Assumption 1 All the units participating in the sharing of information resources in rural areas are independent in terms of function; all the units close the information each other, and they are mutually independent in the process of operation.

Assumption 2 Each unit is a rational person in pursuit of maximizing its own interests.

Assumption 3 All unit systems can generate synergistic effect, that is, the information exchange and business collaboration between various units can produce the effect that does not exist when all units go it alone.

Assumption 4 All the units are strictly under the orders of authoritative leadership units of rural informatization, namely there is no cross-level relationship.

2 Modeling and analysis of the incentive mechanism for sharing of information resourcess in rural areas

2.1 Model establishment

2.1.1 Positive incentive mechanism model. We assume that society S is composed of I units which provide rural information resources. In a split state among i units $\{i \in I\}$, the monopoly power is p_i, and the efficiency of operation alone is r_i. At this point, the overall efficiency of sharing of rural information resources in society is equal to the sum of the operational efficiency of all units and their monopoly power $\sum(r_i + p_i)$.

Assuming that I units providing rural information resources are integrated through the information resources sharing system in rural areas, the original monopoly information owned by all units is integrated into the resources of the entire information resources sharing system in rural areas. The lost unit i's monopoly power due to sharing is p_i, but the operational efficiency increased is δ_i, therefore, society S should offer compensation bi for unit i. At this point, the overall social efficiency = [(the original operational efficiency of various units r_i + the newly added operational efficiency δ_i) − compensation offered by society b_i], namely $\sum(r_i + \delta_i - b_i)$; the rights and interests of unit i = the operational efficiency of this unit ri and the newly added operational efficiency δ_i + compensation offered by society b_i, namely $\sum(r_i + \delta_i + b_i)$.

Thus if we want to achieve cross-unit sharing of rural information resources, we must meet Model I:

$$\text{Max } S = \sum(r_i + \delta_i - b_i) \quad \text{(Social objective function)}$$

$$s.t. \quad \sum(\delta_i - b_i) \geqslant 0 \quad \text{(Social participation constraint)}$$

$$\delta_i + b_i - p_i \geqq 0,\ i \in I \quad \text{(Unit participation constraint)}$$

In Model I, $\sum r_i$ is the efficiency of society S before cross-unit information sharing; $\sum \delta_i$ is the newly added efficiency after cross-unit information sharing; $\sum b_i$ is the compensation paid by the society for the unit in order to achieve cross-unit sharing of information resources in rural areas; $\sum(r_i + \delta_i - b_i)$ is the total efficiency of sharing of information resources in rural areas achieved by the society S, when in cross-unit sharing of information resources in rural areas; $\sum(\delta_i - b_i)$ is the net value added in efficiency brought by the cross-unit sharing of information resources in rural areas to the society; $(\delta_i + b_i - p_i)$ is the net value added in efficiency brought by the cross-unit sharing of information resources in rural areas to the unit i.

Meaning of Model I: Cross-unit sharing of information resources in rural areas should meet the participation constraints of society and various units, and maximize the overall efficiency of the society S.

The participation constraint of society $[\sum(\delta_i - b_i) \geqslant 0]$: The net value added in efficiency brought by the cross-unit sharing of information resources in rural areas to the society S can not be negative; only in this way can the society S have the enthusiasm to promote the cross-unit sharing of information resources in rural areas.

The participation constraint of unit $(\delta_i + b_i - p_i \geqq 0)$: The net value added in efficiency brought by the cross-unit sharing of information resources in rural areas to the unit can not be negative; only in this way can the unit i have the enthusiasm to accept the program of information sharing.

2.1.2 Negative incentive mechanism model. Assuming that unit k does not accept conditions of Model I, making the society S's cross-unit sharing of information resources in rural areas fail, the expected sharing effect $\sum \delta_i$ will disappear. At this point, the society S can design the corresponding negative incentive mechanism, to make unit k, which does not accept the sharing of information resources, pay the sharing effect $\sum \delta_i$ in the situation of participation in the sharing of information resources, in order to make the main results of Model I still valid.

Based on this, the model is transformed into Model II:

$$\text{Max } S = \sum(r_i + \delta_i - b_i) \quad \text{(Social objective function)}$$

$$s.t. \quad \sum(\delta_i - b_i) \geqslant 0 \quad \text{(Social participation constraint)}$$

$$\delta_j + b_j - p_j \geqslant 0 \quad \text{(Participation constraint of unit non-}k\text{)}$$

$$p_k + b_k - \sum \delta_j \geqq 0,\ i, j, k \in I;\ j \neq k \quad \text{(Participation constraint of unit } k\text{)}$$

The difference between Model II and Model I is that Model II lists the participation constraint of unit k, separate from that of other units.

According to Model II, for retaining the information monopoly power p_k, the unit k, which does not participate in the sharing of

information resources in rural areas, must pay the full loss of expected sharing effect $\sum\delta_i$, to the society S, due to sharing failure, in order to ensure that the social objective function, social participation constraint, and participation constraint of unit non-k, are entirely consistent with Model I.

The constraint condition of unit k rejecting sharing of information resources in rural areas ($p_i + b_i - \sum\delta_j \geqq 0$) shows that the net income of unit k ($b_k - \sum\delta_j$) may be negative, but the summation of net income and monopoly power ($p_i + b_i - \sum\delta_j$) can not be negative, otherwise the unit k will not reject the cross-unit information sharing to retain its monopoly power. Thus it can be inferred that only when the monopoly power of unit p_k is very large, can the unit have ability to bear the negative incentive punishment $\sum\delta_j$ arising from rejecting Model I.

2.2 Analysis of correlation between Model I and Model II

The relationship between the above Model I and Model II is a mutually-guaranteed relationship.

First, if there is no deterrence of Model II, then non – cooperation of any unit will make sharing of information resources in rural areas fail; the cross-unit sharing effect $\sum\delta_i$ can not be achieved; the two participation constraint conditions of Model I can not be met at the same time, and the social or cooperative unit will suffer an absolute loss. At this point, there will be no unit (including the society S) willing to choose Model I. However, there is no deterrence of Model II, then on the one hand, each sharing participating unit will be forced to choose Model I, or else the unit will bear the huge cost of punishment, and ordinary units can not afford this cost; on the other hand, even if a handful of units refuse to participate in sharing, for a large number of cooperative units and society S itself, the participation constraint conditions of Model I can still be met, and the partners will not be hurt, because there is corresponding compensation from those non-cooperative units.

Second, if there is no encouragement of Model I, the deterrence of Model II will be incredible. On by the establishment of Model 1 to induce the vast majority of units to rationally choose Model I in accordance with the goal of maximizing their own interests, so as to minimize the number of non-operative units, can the society be free to punish non-cooperators. However, if there is no Model I, then the punishment of Model II is irrational. At this point, if the society sticks to Model II, it will be caught in isolation. The final trade-off result is to give up the punishment, thus the binding effect of Model II will be completely lost. It can be inferred that there is a mutually-guaranteed relationship between Model I and Model II, and only when the two are used at the same can there be effect.

3 Institutional design for sharing of information resources in rural areas

From the above analysis, we can find that the sharing of information resources in rural areas can not be automatically generated, which needs to be ensured by appropriate incentive mechanism. Moreover, in order to effectively encourage the cross-unit sharing of information, there is a need to take positive and negative incentive measures. Thus, we can carry out the propulsion system design of sharing of information resources in rural areas from the following aspects.

3.1 Establishing administrative agency responsible for related work on sharing of information resources in rural areas

It is necessary to establish an administrative agency of rural information resources sharing, above the authority of all units, responsible for related work on sharing of information resources in rural areas. The work duties mainly include the following aspects.

(1) Responsible for the system design, construction and maintenance of sharing of information resources in rural areas.

(2) Conducting coordinated planning, management and supervision on the entire work of sharing of information resources in rural areas.

(3) Responsible for the assessment of information shared by various units, collection of statistics on the use frequency of information, the assessment of the value, and the rating and management of the information quality.

(4) Responsible for the annual performance appraisal on various units' contribution of annual information sharing.

3.2 Establishing and improving the positive and negative incentive mechanisms to ensure the realization of sharing of information resources in rural areas

3.2.1 Establishing the positive incentive mechanism.

First, it is necessary to establish the government compensation system, that is, the administrative bodies of sharing of information resources in rural areas assess the shared information provided by various units, and determine the government compensation amount in accordance with the estimated value. The more the shared information provided by various units, the higher the value of the shared information provided by various units, the higher the compensation obtained.

Second, there is a need to establish the unit annual sharing performance-based reward system, that is, conducting the annual sharing performance appraisal on various units' update frequency of rural information resources, and the participating degree of sharing work. The higher the performance, the more the annual sharing contribution reward received.

3.2.2 Establishing the negative incentive mechanism.

First, we should establish the sharing rejection compensation system, that is, if one unit refuses to provide the sharing information, then the administrative agencies of sharing of information resources in rural areas estimate the reduced value of sharing efficiency arising from rejecting sharing, and use the force of the law to require the compensation.

Second, we should formulate the appraisal system of government officials' performance. For the government, sharing of information resources in rural areas is one aspect of e-government. The e-government does not mesh with China's traditional government

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ment, inventory management, expense management, container management, statistical reports and other functional modules. I preliminarily establish the agricultural informatization system of large farmers' market. Through testing of the system and use of the system in a number of farmers' markets in Shanghai City, I further improve and modify this system. This system can basically realize informatization management of fruit and vegetable agricultural products.

Through the fresh-keeping query function of fruits and vegetables, this system can give play to the role in monitoring and managing the food safety to some extent. If there are problems concerning the quality of agricultural products, we can carry out quality tracing on the agricultural products, through the information database of fruit and vegetable agricultural products. It also provides technical support for the establishment of quality safety traceability system of fruit and vegetable agricultural products.

References

[1] CHEN H, ZHAO J, QIU RZ, *et al*. Design and implement invasive alien species data collection system base on PDA[J]. Journal of Agricultural Mechanization Research, 2011(4): 62 - 66. (in Chinese).

[2] XIE K, QIN Z, WEN JG, *et al*. Combine multi-dimension bloom filter for membership queries[J]. Journal on Communications, 2008, 29(1): 56 - 63. (in Chinese).

[3] WANG XW, JIN BH. Auxiliary supporting system of forests' insect pest [J]. Journal of Anhui Agricultural Sciences, 2010, 38(11): 6017 - 6018. (in Chinese).

[4] ZHANG HY, YUAN YM, HE YH, *et al*. Design and implementation of water quality monitoring system for pond[J]. Journal of Agricultural Mechanization Research, 2011(10): 63 - 65. (in Chinese).

[5] ZHENG RJ, YIN RK, TAO YL. Software engineering in practice[M]. Beijing: Peking University Press, 2010: 10 - 16. (in Chinese).

[6] SUN CH, LIU XX, DING YJ, *et al*. Design and realization of agricultural products circulation traceability system based on Linux embedded technology [J]. Transactions of the Chinese Society of Agricultural Engineering, 2010, 26(4): 208 - 213. (in Chinese).

[7] YANG X . The network marketing of fresh agricultural products in China [J]. Asian Agricultural Research,2011,3(4):125 - 127,131.

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official political incentive system. In order to the smooth progress of sharing of information resources in rural areas and e-government work, there is a need to conduct system innovation to a certain extent, including government affair information sharing in the scope of the functions of government departments, gradually including the progress of the work of sharing of information resources in rural areas into the performance appraisal system of government officials, so that the information resources sharing between the governments becomes mandatory project to be implemented. As for the negative incentive mechanism, if the officials of some government departments always never meet the information needs posed by other units, are always reluctant to conduct the necessary sharing of information resources, then the government will consider whether these government officials can adapt to e-government development, whether these government officials are suitable leadership in the context of e-government sharing environment. And it should downgrade these government officials' performance.

References

[1] ZHANG L. On Chinese agricultural sciences data sharing development[D]. Beijing: Chinese Academy of Agricultural Sciences, 2006. (in Chinese).

[2] GAO YM. The role and function of informatization in socialism new rural construction[J]. Research on Development, 2006(5): 19 - 21. (in Chinese).

[3] WANG LJ, CHU L. Primary analysis on stratagem, model and cultural implications of informatization in building new countryside[J]. China Soft Science, 2007(12): 22 - 27. (in Chinese).

[4] LIU D. On government information resource sharing in China[J]. Contemporary Economics, 2010(11): 36 - 37. (in Chinese).

[5] MA FC, JING JP. Information economic analysis[M]. Beijing: Scientific and Technical Documentation Press, 2004: 3. (in Chinese).

[6] LI RF. Discussion and research on county agricultural information resource integration model in Yunnan Province[J]. Journal of Anhui Agricultural Sciences, 2012,40(20): 4966 - 4969. (in Chinese).

[7] LIU YM, YIN FF, FU XZ. Analysis of information sharing mechanism in the food industry green supply chain management and operation process[J]. Asian Agricultural Research,2011,3(2):86 - 90.