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ITJ

ISSN 1812-5638

INFORMATION TECHNOLOGY JOURNAL

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Information Technology Journal 12 (23): 7910-7913, 2013
ISSN 1812-5638 / DOI: 10.3923/itj.2013.7910.7913

A Study on the Contract Arrangement of Technology Transfer Model in China Information Technology Industry

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Abstract: By comparing with previous work and building technology transfer model in information technology industry into the external enterprise contract approval model, the technology transfer model involving information technology professionals, a technology transfer center and an enterprise is constructed in a mathematic way. It is proved that in the external enterprise contract approval model, uncooperative equilibrium exists in information technology professional and enterprise. The core innovation of this paper is whether information technology professionals or enterprises will participate in technology transfer depending on marginal revenue of information technology professionals and the marginal investment cost of the technology transfer.

Key words: Information technology industry, technology transfer, contract arrangement

INTRODUCTION

The modern information technology has greatly promoted the development of the global economy. Technological innovation in information technology industry plays a significant role in promoting economic and social development of our country. In fact, the result of technology transfer is not satisfactory. Most scholars think that this phenomenon is due to problems of system such as the imperfection of China's technological achievement management system and the irrationality of evaluation and incentive system of information technology professionals. However, the author thinks that the low technology transfer rate tends to be a global issue: the technology transfer of information technology research and development facilities has its own features of multi-agent, multi-objective and multi-model, which involves information technology professionals (inventors), enterprises (transferees) and technology transfer center (TTC for short) as its main participants. Any decision-making actions of these participants will have strong influence on the efficiency and result of technology transfer. Compared with other ordinary technology transfers, information technology transfer faces special problems such as investment, time-consumption and great risk. Only when the decision purpose and interest relationships among related sides are clarified can the deadlock of the unsatisfactory technology transfer in biomedical research and development facilities be broken to some degree.

LITERATURE REVIEW

Technology transfer contract arrangement and model application: As the inventor of the technological achievements, the information technology professional has two main types of technology transfer model. In the external enterprise contract approval model, domestic companies usually have to work together with information technology professionals to complete follow-up industrialization, which requires TTC to coordinate the relations between information technology professionals and companies to avoid moral risk. On the one hand, TTC should stimulate companies to invest enough resources of research and development for the technology transfer of universities. On the other hand, TTC should prevent information technology professionals from neglecting their duty during the process of cooperation and ensure that information technology professionals make enough efforts to the technology transfer. Thus, in the external enterprise contract approval model, the relation among TTC, information technology professionals and companies can be regarded as the Principal - Agent relation. As a principal, TTC should make a rational technology transfer contract for information technology professionals and companies to eliminate moral risk.

In the information technology professional entrepreneurship model, information technology professionals use their technological achievements to start their own businesses. Features of this model are as follows: Firstly, because the information technology

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professional's goal tends to be consistent with that of his newly established firm,it is almost impossible to neglect duty; Secondly, as the proprietary rights of technological achievements belong to universities, there are conflicts of economic interests between information technology professionals and TTC. Information technology professionals always hope that TTC can reduce its licensing fees to cut down operating costs of their newly established companies; Finally, there is a high-degree information asymmetry. Information technology professionals have opportunity to take the "speculative behavior". They may transfer the technological achievements personally instead of disclosing them to universities.

Burnside and Witkin (2008) considered that the best technology transfer model was to establish research and development centers of companies and to develop the substantial cooperation between companies and universities so that companies and scientific research facilities could work together to do researches. Frew *et al.* (2008) found that China had been increasing technology investment while technology and economy had not interacted yet. Facing this "two skin phenomenon" of technology and economy, He (2012) put forward" industry-university-research institutions" (IUR for short) collaborative innovation model which aims at the "strategy –knowledge-organization" triple interaction. He also built a new analytic framework of IUR collaborative innovation, namely he made analysis from strategic coordination perspective, knowledge coordination perspective and organizational coordination perspective and did related exploration of building a preliminary theoretical framework of IUR collaborative innovation.

Comments on the relevant literature: Li and Pu (2007), Thursby and Thursby (2007) and Liu and Chen (2008) have discussed either of two kinds of main technology transfer models, respectively in their papers. But the author thinks that the following problems are still worth our attention. Firstly, for TTC, both of two technology transfer models are rational and feasible. So it still remains to be investigated how we select the best technology transfer model in a particular situation and make a rational technology licensing contract. Secondly, information technology professionals and TTC may not make the same optimal decision when they select a technology transfer model. Therefore, it is worthy of study how we identify and remove this inconsistency through the theoretical analysis.

All in all, based on the articles written by Li and Pu (2007), Thursby and Thursby (2007) and Liu and Chen (2008), the author applies the principal-agent theory and the master-slave game theory to build game models of university technology transfer in external enterprise contract approval model and information technology professional entrepreneurship model respectively. The author expects to provide some guidance for the management of scientific and technical achievements.

BASIC ASSUMPTIONS AND DEFINITIONS OF VARIABLES

The technology transfer in information technology industry is confronted with problems, such as high investment, time-consuming and huge risk, etc. The transfer system is featured by multi-agent, multi-objective and multi-model with information technology professionals (inventors), enterprises (transferees) and TTC involving.

- Licensing revenue is necessary for TTC to guarantee its daily operation and mobilization of information technology professionals. Therefore, for the sake of brevity, in this article it is still assumed that maximization of benefit of TTC is behind its decision
- In this study, it is supposed that information technology professionals' expected economic interest consists of income, licensing revenue for participating in technology transfer and return on equity of entrepreneurship success. Given by high transfer cost, long period and high risk, which may reduce the expected economic interest of information technology professionals, the logarithmic function of expected effect for information technology professionals is:

$$U_R = In(M_R) \quad (1)$$

Hereinto, M_R refers to expected economic interest of information technology professionals participating in technology transfer.

- In this study, a model of nonrecurring fixed licensing fee plus mortgaged commission is used. The commission is linearly relative to the net profit of pharmaceutical enterprises. Since the fixed licensing fee has limited influence on the follow-up decisions made by technology transfer participants, it can be assumed as the exogenous variable of the system
- A successful technology transfer depends on the efforts of information technology professionals (inventors) and pharmaceutical enterprises (transferee). The effort levels of information technology professional and pharmaceutica

enterprises participating in technology transfer are assumed respectively as e and s and $I_{(e)}$ and $Q_{(s)}$ as their functions. $T_{(e)}$ and $Q_{(s)}$ satisfies the equation I(0) = Q(0) = 0. Since I'(e)>0, Q'(s)>0 and the declining marginal efficiency of effort from information technology professionals and enterprises, the result is I"(e)<0, Q"(s)<0

Other symbols are defined as follows: π(e,s) represent separately the net profit obtained by external enterprises and information technology professionals from newly established enterprise. If efforts of either side is zero, the net profit is zero, π(0,s) = π(e,0) = 0 and π'(e,s)>0 m stands for fixed licensing fee, a for the proportion of licensing contract for information technology professionals determined by TTC, s for search cost of TTC, k for the annual salary of information technology professionals; T for the time spent in technology research and transfer by information technology professionals, γ for risk factor of study time.

MODEL BUILDING: EXTERNAL ENTERPRISE CONTRACT APPROVAL MODEL

According to external enterprise contract approval model, firstly TTC will negotiate with external enterprises in order to ensure technology licensing contract approved by both sides (including fixed licensing fee and proportion of net income) and TTC determines,on its own, proportion of licensing contract. Then information technology professionals and external enterprises will jointly decide the effort level of sequent technology transfer,during which Principal-Agent relationship will be formed, principal being TTC and agent being information technology professionals and external enterprises.

Expected economic profit of external enterprises $M_F = (1-\lambda)\pi(e,s)-m-Q(s)$.

Expected economic interest of information technology professionals:

$$M_R = S+\alpha\lambda\pi(e,s)+\alpha m-I(e)-\gamma T$$

Expected economic utility $U_R = In(M_R) = In (S+\alpha\lambda\pi(e,s)+\alpha m-I(e)-\gamma T)$. The prerequisites of external enterprises and information technology professionals participating in technology transfer, respectively, are: $M_F>0$, $U_R>0$.

Expected economic interest of TTC, E_T, can be calculated as $M_T = (\alpha, \lambda) = (1-\alpha)(\lambda\pi(e,s)+m)-k$.

Valuing α and λ, the optimal effort level of external enterprises and information technology professionals is:

$$\frac{\partial M_F}{\partial s}=(1-\lambda)\pi_s'(e,s)-Q'(s) \quad (2)$$

$$\frac{\partial U_R}{\partial e}=\frac{\alpha\lambda\pi_e'(e,s)-I'(e)}{S+\alpha\lambda\pi_e(e,s)+\alpha m-I(e)-\gamma T} \quad (3)$$

Conclusion 1: Uncooperative Equilibrium exists in the following cases: either information technology professionals or external enterprises neglect their duty or effort level is zero; proportion of net income is zero.

Proving process: In the former case, if effort level of information technology professionals e = 0, B(0) = 0, then expected economic profit of enterprises is $M_F = -m-Q(s)$. Obviously, under this circumstance, enterprises will not take any efforts in technology transfer. For the same reason, while s = 0, the optimal effort level of information technology professionals $e^* = 0$.

In the later case, when λ = 0, expected economic interest of information technology professionals is S+αm-I(e)-γT and:

$$\frac{\partial U_R}{\partial e}=-\frac{I'(e)}{S+\alpha m-I(e)-\gamma T}<0$$

which indicates that expected utility of information technology professionals declines with the increase of effort level. Therefore, when the optimal effort level of information technology professionals is zero, the case will be the same as the former one in which enterprises will take no efforts.

Apparently, when TTC gives license of technology to external enterprises, TTC's licensing prerequisites must include that proportion of net income is positive so as to take advantage of residual claims for technological achievements to stimulate information technology professionals to participate in the sequent technology transfer. Otherwise, they are very likely to turn out to be "hand-off bosses". Furthermore, the joint effort of information technology professionals and enterprises is necessary for successful technology transfer. Due to information asymmetry, technology transfer will be inefficient if either of the two sides neglects its duty.

Conclusion 2: Only if the marginal revenue of pharmaceutical technology transfer for researchers exceeds its marginal cost, researchers will make efforts to lift effort level for technological achievements.

Proving process:

$$\frac{\partial M_R}{\partial e}=\alpha\lambda\pi_e'(e,s)-I'(e)$$

after the proportion of licensing contract and proportion of net income have been determined by TTC in the form of contract, economic profit will increase with the improvement of effort level to further develop technological achievements by researchers. But only if marginal revenue for researchers exceeds marginal cost for technology transfer, expected economic interest of researchers will increase with the advancement of effort level. Or their effort level may be lower than the optimal effort level e^*. It can also explain reticence about core knowledge in the process of technology transfer by the researchers in a position of information advantage for consideration of balance between cost and interest, which may lead to an ethical crisis.

POLICIES AND SUGGESTIONS

Being a main creative subject of scientific achievements, the scientific information technology professionals play a crucial role: Information technology professionals are the creators of technological achievements, so they are supposed to improve R and D level, to break through the technical bottleneck in the industrial restructuring with market demand as a standard, to strive to improve the technology quality and to accelerate the progress of industrialization for the technological achievements. What's more, we should make the best of the information advantages that the information technology professionals have, stimulate them to transfer the technology and lead them to abiding the system of technology transfer without any "speculative behavior".

Being a bridge of technology transfer, TTC plays a significant role: TTC should positively expedite the industrialization for technological achievements and perform the role of bridge to associate information technology professionals with enterprises. At the same time, it is necessary to establish thorough technology transfer mechanism and contract system, keep a balance among different profits bodies, reduce the moral risk resulting from information asymmetry in the process of technology transfer and form protection mechanism with a favorable transfer motivation.

Being demanders for the technology transfer, the enterprises shoulder heavy responsibilities: Information technology enterprises should aim at a sustainable development and strengthen the effort to invest and introduce the R and D resources, such as, R and D talents, capitals, devices, etc., to improve anti-risk capability. In addition, they should scientifically plan and introduce technology contract arrangements to match the technological achievements, increase the quality and efficiency of digesting and absorbing the introduced technology and innovate continuously in information technology through successive development so as to improve competitive forces of the technology.

ACKNOWLEDGMENT

The authors would like to thank for the support by 2013 Jiangsu Province Soft Science research under the Grant BR2013010. The authors also thank for the support by the education of Jiangsu Province "12th Five-Year Plan" Planning Issues under the Grant D/2013/01/007 and the 2013 National Undergraduate Innovative Experiment Program under the Grant 201310290055.

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