Research on Motivational Mechanism of University Teachers under R&D-Type Industry-University-Research Cooperation Model[*]

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Abstract   This paper researches on the motivational mechanism of university teachers under R&D-type Industry-University-Research cooperation model. Firstly, the paper defines the concept and the model of the Industry-University-Research cooperation; then, it describes the principal-agent relationship which exists under R&D-type Industry-University-Research cooperation model. And the paper establishes the motivational mechanism of university teachers through mathematical model. Lastly, we can draw the conclusion that universities should promote the capability of university teachers and enterprises should reduce the coefficient of profits share properly.

Key words   Industry-university-research; R&D-type cooperation model; Motivational mechanism

1 Introduction

At present, Industry-University-Research cooperation in the main developed countries in the world is very common, but for the motivational mechanism of university teachers in this research is very little. Only through the current situation of the Industry-University-Research cooperation to analyze the motivational mechanism or through the motivational mechanism of the university teachers and knowledge workers get the information of motivation for university teachers in Industry-University-Research cooperation.

1.1 The general situation of international research

Foreign motivational mechanism on the research is mainly from knowledge management and project management, analyzes the motivation problem of "Industry-University-Research cooperation" and motivation factors. Kenneth A. Smith indicates that the university students are the main power of the industry development, so the industry motivation for university teachers is very important. American scholar Lee Yong. S (1996) who focuses on the authentic proof study in colleges, find out that the best choice of Industry-University-Research cooperation model is principal research.

Foreign scholars' research on university teachers' motivational problems focuses on two aspects such as motivational mechanism with its influencing factors and the teachers' personal levels. Just for motivational mechanism influencing factors, Thomas J. Sergiovanni thinks moral is the biggest power of teachers' work motivation. Craig's study shows that raising their social status can arouse teachers love on their jobs, thereby reducing the loss of teachers. David W. Johnson and Roger T. Johnson mentions in their study that cooperation is a good way to encourage teachers. For College teachers' personal level, E. Mark Hanson thinks that teachers' working motivation usually includes job working conditions, the nature of the job and personal considerations.

Harvard University psychologist William James in the motivational study of workers finds knowledge workers can greatly improve their abilities after encouraged. And Mahen Tampoe's study finds knowledge workers pay more attention to the challenging work that can constantly improve their developments, and will pursuit their growth of knowledge, individual and business restlessly. The need of strength for motivational factors is different for knowledge workers in different stages of development. In addition, some scholars think consultation and participation are the two tools that digging the enterprise's internal intellectual capital.

1.2 The general situation of domestic research

Industry-University-Research cooperation of domestic research focuses on the incentive compatibility mechanism and cooperation among the interior motivational mechanism of the body. Chen Xiangfeng analyses incentive compatibility mechanism of Industry-University-Research cooperation indicates that the incentive compatibility refers to the combination of subjective for him to production, learning and research to make them all, through trade, objectively division and for the whole society's scientific and technological progress to work, so as to realize the mutual interaction with the uniform. Although production, study and research pursue different objective functions, but due to the union,

making each other's benefits become cross-reactivity because various forms of cooperation, and thus get economy increasing returns to scale. Shen Yongliang (2004) in its master degree thesis points out, in the cooperative innovation of scientific research institutes, if universities or research institutes' behavior can not be observed; cooperation must be induced by incentive compatibility mechanism.

Domestic scholar Li Chongfeng's study of the motivational mechanism suggests that the teachers' behavior motivation is very necessary. School administrators should adopt some strategies for teachers' development; teachers should encourage each other in order to achieve common development. Teachers should be self-motivated, and seek self development. Xu Zengyong and Sun Guangfu think that need is the power of action, correct understanding to the particularity needs of university teachers, and according to different objects take different methods are reasonable. Based on the principal-agent theory, Scholars such as Fan Kewei, Zhao Linping, Zhang Chenghua etc. establish function, put forward the incentive model of university teachers.

At present domestic scholars' study of the knowledge workers motivational mechanism is based on the analysis from the study of the knowledge workers demanding characteristics, in order to find motivational measures, but very little are analyzed from knowledge workers' behavior characteristics.

In short, current study of motivational mechanism in Industry-University-Research cooperation is very little. And the study of university teachers' motivation model in Industry-University-Research cooperation has a lot of research potential. According to the motivational mechanism of Industry-University-Research cooperation, the motivational mechanism of university teachers and motivational mechanism knowledge workers can be seen, the research achievements in Industry-University-Research cooperation of university teachers' motivation is feasible and very meaningful.

2 The Conception of Industry-University-Research Cooperation

The Industry-University-Research cooperation is under the environment which supporting by the country, and it seen enterprises, colleges, research institutes, government and agencies as basic elements, engaging the scientific research, talent nurturing, market developing, etc. through interaction of each element, and then establish the organization form of the Industry-University-Research cooperation to achieve technology innovation, social service, industry development and economy improvement[1]. Among these elements, enterprises, colleges, research institutions are internal basic principal parts. Enterprises play a leading role in the Industry-University-Research cooperation, while colleges and research institutions serve as crucial support. And government and agencies are external principal parts. Government leads the Industry-University-Research cooperation, while the agencies link it.
The Industry-University-Research cooperation can be clearly denoted in Figure 1.

3 Classification of the Industry-University-Research Cooperation Model

The Industry-University-Research cooperation is a systematic engineering that refers to multi subjects with intrinsic structure and function among them. In order to clarify the problem of the Industry-University-Research cooperation, it is highly important to define its model. The Industry-University-Research cooperation model is identifying of different cooperation ways and types between basic cooperative subjects or internal and external principal parts, which can be used for reference, and promotion or innovation.

This paper divides the Industry-University-Research cooperation into 3 models, according to different aims of enterprises participating Industry-University-Research cooperation and drawing lessons from the classification of Professor Wang Zhangbao, such as talent nurturing pattern, research & development pattern, and intersubjective synthesis pattern [2].

3.1 The pattern of talent nurturing cooperation model

The pattern of talent nurturing is also named as the pattern of cooperative education. In the ages of knowledge economy, talent is a decisive element to deciding success or failure in an enterprise. In order to training qualified employees of who are specialized in marketing, production, and technical development, enterprises usually work with colleges to foster talent in such ways, as entrusted training, joint education programs, base co-building and mutual pluralism. Colleges are beneficiaries in this model that they not only culturing special talent for enterprises but also raising the rate of employment for their graduates. And the colleges also earn very good social reputation with their qualified graduates' strong practical and innovative ability.

3.2 The pattern of research and development cooperation model

1. research results
2. college graduates
3. product services
4. profit and tax
5. consultation
6. colleges and research institutions
7. enterprises
8. macro guidance
9. policy support
10. innovation atmosphere
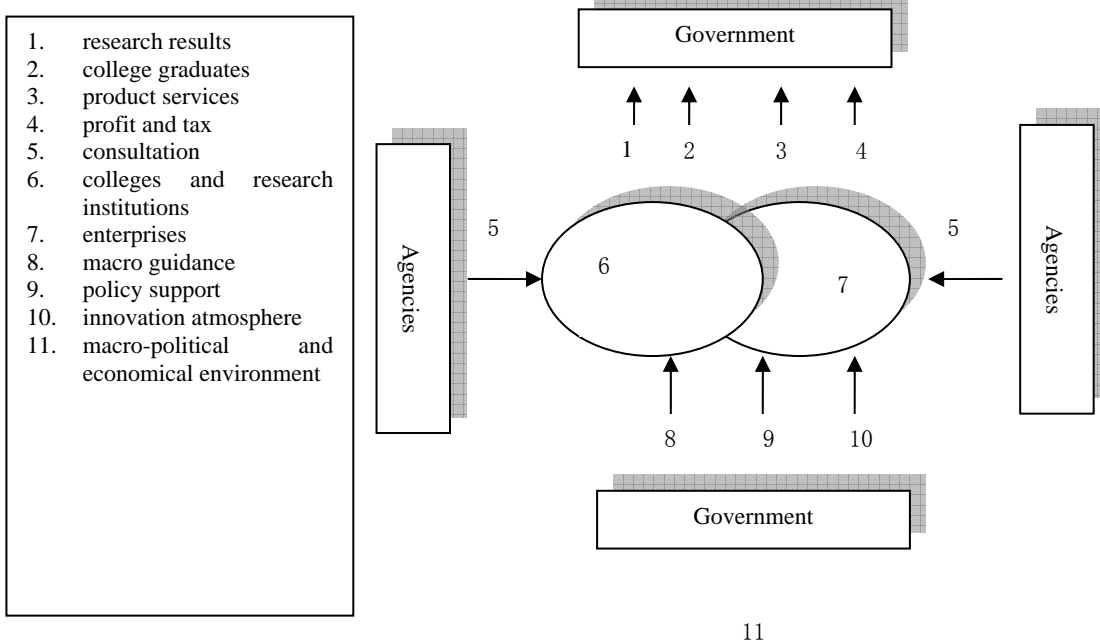11. macro-political and economical environment

Figure 1   The Diagram of Industry-University-Research Cooperation

The purpose of this model is to promote the innovative ability of all parties, in other words to raise the enterprises' technical innovative ability quickly and to accelerate the transformation of college research results. Based on strong scientific research power, colleges work with enterprises, which have huge fund, to speed up the transformation of research results into productivity, or to accelerate science and technology more closely combining with economy. This essential and active model usually takes the following forms as: technology transfer, technical consultation & services, coalition in major scientific research tasks or engineering projects, joint participation in the Industry-University-Research cooperation development project, and co-build R&D entities, etc.

3.3 The pattern of intersubjective synthesis cooperation model

Both the above the two models assume that enterprises have only one purpose—they either need highly qualified talents (as in pattern I) or enhance their own innovative ability (as in pattern II). But enterprises of participating the Industry-University-Research cooperation may have multi-purposes—they want to cultivate talents as well as accelerate innovative ability. Such multi-purpose cooperation between enterprises and colleges are called intersubjective synthesis pattern cooperation model, which requires cooperative entities to collaborate in multi-orientations deeply and make the best profit at the same time.

4 The Analysis of the Principal-agent Relationship under the R&D-type Industry-University-Research Cooperation Model

Under the R&D-type Industry-university-Research cooperation model, enterprises and colleges form the principal-agent relationship in line with the following 2 conditions:

①This paper strictly confines the entities of the Industry-University-Research cooperation as enterprises and colleges. According to the above analysis, the information which they master is asymmetrical due to different social divisions of labor. Enterprises hold huge funds and productivity, who know their situations well while colleges are hard to see the real picture of enterprises comprehensively. Similarly, human resources in colleges are hard to be monitored. College teachers know their own research capability, but enterprises don't. If enterprises want to know these teachers' actual research works completely, they have to do some necessary supervising, but the cost is very high. Neither enterprises nor colleges can fully understand the information from the other part, thus, the information between them is asymmetrical.

②Both enterprises and colleges are rational economic bodies who pursue the best value for

themselves. But their basic interests are not the same. Enterprises want the biggest profit. However, what colleges pursue is much more than this—they seek for school reputation, individual fame and other social effects. Because of different interest pursuit, agents in the Industry-University-Research cooperation may harm their consigners' benefit to satisfy their own. Consequently, agents need to design proper simulative contract to ensure their clients and themselves obtain the best benefit.

The Industry-University-Research cooperative principal-agent relationship actually means the relationship between collaborators that's with information advantaged and disadvantaged. Simply speaking, either before or after the relationship is established, if the information is not symmetric between collaborators, the bond can be described as agent-client relationship. The party with information advantages is called agent; the party with information disadvantages is called client or consigner. This paper presumes that enterprises are consigners and colleges agents in the R&D-type cooperation model.

It shows that the R&D-type Industry-University-Research cooperation involves principal-agent relationship; because of the problems that affect by the relationship in turn affect the Industry-University-Research cooperation. Accurate understanding of these issues is the key to solve these problems and only by doing so can the Industry-University-Research cooperation carry out smoothly and its economic and social benefits develop the best affect.

5 Research about University Teacher Motional Mechanism in R&D-type Industry –University-Research Cooperation Model

One way to solve the problem of agents may be hurt clients due to asymmetrical information in the Industry-University-Research cooperation is to establish a motivational-restriction system for agents. According to the principal-agent theory of information economics, motional mechanism is a kind of special asymmetrical information countermeasure, whose designer, clients, attracts agents with more information act in accordance with clients' interest for their own. In principal-agent relationship defined in this paper, enterprises should design motional mechanism—contracts or motivating plans to urge college teachers to fulfill their tasks.

5.1 The construction of motivational models
5.1.1 Pre-hypotheses

For convenient modeling and description, the following hypotheses are made:

Hypothesis I: Suppose college teachers are agents that they have informational advantages in the Industry-University-Research cooperation; enterprises are clients that they have informational disadvantages. In the following text, enterprise is client and college teacher is agent. College teachers' behaviors in the Industry-University-Research cooperation have an impact on enterprises' interest. Enterprises and colleges cooperate under circumstances of asymmetric information in that enterprises can't observe college teachers' action choice a and external variant θ, but produce π.

Hypothesis II: Suppose enterprises are neutral risk taker, its utility function is $v(\pi-S(\pi))$, and college teachers are risk evaders, the agent's utility function are fixed absolutely risk evading, i.e. $u=-e^{-\rho\omega}$ ($0<\rho<1$ is the absolute risk evading measurement; ω is the actual monetary income).

Hypothesis III: the model satisfies college teachers' individual rationality constraint, i.e. they participate in the model where their obtained utility is greater than their reserved utility. (There is a hidden hypothesis that the agent market is completely competitive, and agent's reserved utility can be seen as correspondent to market salary. Such hypothesis excludes bargains between agents and clients)[3]. And meanwhile, the model satisfies motivational compatibility constraint, i.e. the motivational contract designed by client attracts agents act to the best result for clients based on their own interest.

5.1.2 Model construction and its solution

(1) Both enterprises and college teachers are rational participants of the Industry-University-Research cooperation whose output depends on college teachers' hard work. Suppose a is college teachers' variate of hard work, then its outcome is the function of how hard they work. But outcome does not only rely on college teachers' hard work, the uncertainty brought about by external variant θ can also affect it. Here let's assume the random variant takes normal distribution when the average of θ is zero, and variance is σ^2. If output function takes the following linear form: $\pi = a+\theta$, $\theta \sim N(0,\sigma^2)$.

(2) Effort income of college teachers is linear function about outcome, $S(\pi) = \alpha + \beta\pi$, α is

basic pay of work irrelevant to how hard they work; β is profit sharing coefficient—the agents' portion shared from the work benefit π. Obviously, $0 \leq \beta \leq 1$.

(3) C, the cost of agents' work, is the quadratic function of effort level a; assume $C(a) = \frac{1}{2}ba^2$, $b > 0$, where b is agents' cost coefficient representing agents' efficiency, the smaller b is, the stronger its ability. $C'(a) > 0$, $C''(a) > 0$ means agents' general cost and marginal cost increase with their efforts.

(4) The Industry-University-Research cooperation affects college teachers' fame and its equivalent monetary income utility is $E^t \varepsilon \pi$ where ε is fame influence coefficient, $\varepsilon < 1$ and $\varepsilon \neq 0$, t is career span, $t > 0$, E is a constant bigger than 1[4].

On the basis of the above hypotheses, clients' risk is neutral and their certain equivalent income is their expectation of real yield, i.e. clients' certain equivalent income is.

Clients' prospective income, which means their certain equivalent income, is

$$E(\pi - W(\pi)) = E((1-\beta)a - \alpha + (1-\beta)\theta) = (1-\beta)a - \alpha$$

Since fame factors are hidden elements, agents' real income is effort income plus income brought by hidden elements and minus effort cost, we get

$$u = \alpha + \beta\pi + E^t \varepsilon \pi - \frac{1}{2}ba^2 = \alpha + (a+\theta)(\beta + E^t\varepsilon) - \frac{1}{2}ba^2$$

For agents are strict risk evaders, their certain equivalent income is

$$E(u) - \frac{1}{2}\rho\,\mathrm{var}(W(\pi)) = \alpha + a(\beta + E^t\varepsilon) - \frac{1}{2}ba^2 - \frac{1}{2}\rho(\beta + E^t\varepsilon)^2\sigma^2$$

Where $E(w)$ is agents' prospective income, $\frac{1}{2}\rho(\beta + E^t\varepsilon)^2\sigma^2$ is agents' risk cost.

Let ϖ be employees' reserved utility, i.e. random cost. If certain equivalent income is smaller than ϖ, then employees will deny the contract, so their participant restraint can be demonstrated as

$$\alpha + a(\beta + E^t\varepsilon) - \frac{1}{2}ba^2 - \frac{1}{2}\rho(\beta + E^t\varepsilon)^2\sigma^2 \geq \varpi$$

Agents' motivational compatibility restraint is

$$\max\left(\alpha + a(\beta + E^t\varepsilon) - \frac{1}{2}ba^2 - \frac{1}{2}\rho(\beta + E^t\varepsilon)^2\sigma^2\right)$$

So far, incentive question has been transformed into how to ensure the parameters in the contract to maximize clients' benefits when participant restraint and motivational restraint are satisfied. Its optimized model is like this,

$$\max(1-\beta)a - \alpha \tag{1}$$

$$\text{S.T. (IR)}\quad \alpha + a(\beta + E^t\varepsilon) - \frac{1}{2}ba^2 - \frac{1}{2}\rho(\beta + E^t\varepsilon)^2\sigma^2 \geq \varpi \tag{2}$$

$$\text{(IC)}\quad \max\left(\alpha + a(\beta + E^t\varepsilon) - \frac{1}{2}ba^2 - \frac{1}{2}\rho(\beta + E^t\varepsilon)^2\sigma\right) \tag{3}$$

From the first-order condition, we get $\frac{\partial u}{\partial a} = 0$, that is $\beta + E^t - ba = 0$, so $a = \frac{\beta + E^t\varepsilon}{b}$; therefore, college teachers' effort cost coefficient b, profit sharing coefficient β, fame influence coefficient ε, and career span t determine effort level.

5.2 Analysis of motivational model

College teachers' effort level is $a = \frac{\beta + E^t\varepsilon}{b}$, which indicates that the effort level is relevant to effort cost coefficient b, profit sharing coefficient β, fame influence coefficient ε, and career span t.

Analysis 1: College teachers' effort level is in reverse to effort cost coefficient b which represents agents' ability; the smaller the b is, the greater the ability is. On condition that coefficient of profit-sharing, coefficient of reputation influenced and career time are fixed, the smaller b is, the greater

the effort level is.

Analysis 2: College teachers' effort level and coefficient of profit-sharing β vary in the same direction, on condition that effort cost coefficient, coefficient of reputation influence ε and career time t are fixed, the higher β is, the more actively college teachers will work.

Analysis 3: College teachers' effort level, coefficient of reputation influence ε, and career time t vary in the same direction, and on condition that effort cost coefficient b, coefficient of profit-sharing β and career time t are fixed, the higher the coefficient of reputation influence is, the more actively college teachers will work.

Analysis 4: On condition that effort level a and cost coefficient b are fixed, coefficient of profit-sharing β and coefficient of reputation influence ε are substitutable. College teachers' attitude towards reputation should be concerned in analysis of employees' effort level.

5.3 Suggestions on motivational measures

Firstly: College teachers' effort level is in reverse to effort cost coefficient b, so we may strengthen their ability and decrease effort cost coefficient. Enterprise should get in touch with university teachers and make them participated in all kinds of corporation business often, so they could understand the stratagem of corporation development and R&D, then they'll purposively associate their scientific research in ordinary work and participate in Industry-University-Research cooperation by decreasing effort cost coefficient b, so they can participate in R&D better.

Secondly: Because university teacher is a special group which belongs to employee who has knowledge and cherishes the peculiarity of himself, i.e. coefficient of reputation influenced is higher. So the excitation for them is different from common employee. Based on the analysis of above paragraphs, coefficient of profit-sharing is in reverse to reputation influenced and personal career time, the more ε、t is，the less β is. In other words, considering the fame influence of reputation and career-planning time of university teacher, enterprise may relevantly decrease coefficient of profit-share and encourage them participate in Industry-University-Research cooperation by spiritual prompting.

6 Conclusions

This paper mainly studies the university teacher motional mechanism in R&D-type Industry-University-Research cooperation model. Firstly, defining its conception, and then presenting the three kinds of cooperation model: talent nurturing pattern, research & development pattern, and intersubjective synthesis pattern. When principal-agent relationship in R&D-type Industry-University-Research cooperation model is analyzed, the conclusion is that problems may derive from this principal-agent relationship. One of the solutions is to establish motive-restricting system. The fourth part of this paper presents two suggestions through the model: one is organizing university teachers to participate in enterprises' R&D often, so they can know enterprises better, and their effort level can be increased by decreasing effort cost coefficient; the other is to decrease coefficient of profit-sharing considering the importance of reputation to them, and encourage them to participate in the Industry-University-Research cooperation through spiritual prompting.

References

[1] Zhou Jinzhen, Wan Yugang, Gao Jin. Research on Innovational Industry-University-Research Cooperation Model of China[J]. Scientific-Technical Progress and Strategy (In Chinese)

[2] Wang Zhangbao. Industry-University-Research Cooperation: Model, Trend, Problem and Strategy[J]. Scientific-Technical Progress and Strategy (In Chinese)

[3] Zhang Weiying. Gametheory and Informational Economics[M]. Shanghai San Lien Publishing House (In Chinese)

[4] Chi Ying. Research on Motivational Mechanism of R&D-Team[D]. Master's Degree Thesis of Xi'an University of Science and Technology, 2006 (In Chinese)