

Incentive Research of Information Technology Outsourcing of Both Principal and Agent's Risk Aversion

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Abstract

The paper mainly analyzes information technology outsourcing incentive problems of both principal and the agent's risk aversion under unilateral moral hazard. Outsourcing incentive mainly achieves goals of motivation toward the agent through adjustment and balance of the effort level and output sharing proportion. The conclusions are: Firstly, the more the external uncertainties influence, the lower output sharing proportion and effort level are; secondly, the bigger risk aversion is, the lower income both sides will get; thirdly, the bigger the cost coefficient of the agent is, the less income the principal can get.

Key words: IT outsourcing; Incentive; Moral hazard; Risk aversion

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INTRODUCTION

Since Kodak Company outsourced their IT business to IBM, IT outsourcing has become more and more popular in the world. Some scholars pointed out that IT outsourcing can bring organization benefits, such as improving organizational performance (Gilley & Rasheed, 2000), sustaining competitive advantage (Sadiq, 2011), increasing business efficiency (Agrawal & Haleem, 2013), stimulating innovation (Su, Levina, & Ross, 2016), etc..

Whatever the relationship between IT outsourcing and organizational performance is, IT outsourcing has become one economic trend.

In the actual IT outsourcing market, there is information asymmetry between the principal and the agent. Generally speaking, agent masters more information advantage: Compared with the principal, the agent knows more about cost, his professional qualities, the outsourcing market quotation, etc.. As the information asymmetry exists, the problem of adverse selection and moral-hazard is inevitable, namely the agent may hurt the principal's interests by his information advantage. Therefore, it is vital to sign contract to safeguard the interests of both parties. The design of outsourcing contract is the main method to overcome adverse selection and moral-hazard (Shi & Wang, 2011; Song, Dan, & Zhang, 2010).

So far, the literature that related with IT outsourcing have assumed the principal's risk neutrality and the agent's risk aversion, such as literature (Li, Song, & Xu, 2013; Gao, Wei, & Li, 2008; Wang & Hou, 2014; Holmstrom, 1999). These assumptions are both reasonable and logical; however, we cannot neglect a fact: For the principal and the agent, they all need risk aversion because risks are everywhere and the outsourcing market is fluctuant. Therefore, is maybe biased to consider only the agent needs risk aversion, as an economic man, the principal also needs risk aversion.

Holmstrom et al. (1987) researched that moral hazard arose from the uncertainties of the final output of the contract. Jullien et al. (2006) found that in the principal-agent situations, the bigger the risk aversion of the agent, the worse motivation toward the agent. Gritzalis et al. (2007) researched IT outsourcing incentive probability model that can ensure the client's information security. Belhaj et al. (2014) explored the moral hazard problem of both the principal and the agent's risk aversion and concluded that intensity of moral hazard depended

on investment risk predictability degree. When the investment risk can be observed, the motivation can be more effective relatively. Tseng et al. (2014) studied moral hazard in the maintenance outsourcing and designed incentive contract that based on performance. They found if the agent's risk aversion was high, it was more difficult for both sides' channel coordination.

1. PROBLEM DESCRIPTION

Assumption 1: The principal and the agent are the economic man. They try utmost to pursue the maximum profits for themselves. They won't do anything that may hurt interests of themselves.

Assumption 2: After signing the contract, the agent is responsible for the contract. The effort level of the agent is directly related with final output and can be determined by the agent. Obviously, the higher the effort level is, the more output can be obtained. The output function is $\pi = e + \varepsilon$. Variable e is the effort level of the agent, and ε measures the external uncertainties that can impact the final output and can be controlled by the agent. $\varepsilon \in N(0, \sigma^2)$.

Assumption 3: The payment mode is $P = \alpha + \beta\pi$, namely the principal will pay a fixed payment α to the agent, $\alpha > 0$. Then the principal will pay the agent according to the agent's final output and determine the sharing proportion β , $0 < \beta < 1$. We can find that if $\beta = 0$, and then the principal will undertake all the risks in the outsourcing because whatever the final output is, he has accomplished payment. If $\beta = 1$, then the agent will undertake all the risks in the outsourcing process because no matter how hard he tries, his revenue is absolutely determined by the principal's judgment to his final output.

Assumption 4: The agent can choose his effort level. The higher the effort level is, the higher his cost is because he should invest more resources, such as money, energy, time, etc.. The agent's cost function is $C = 0.5be^2$, b means cost coefficient.

Assumption 5: Define π_1 as the principal's revenue and π_2 as the agent's revenue. Define $E\pi_1$ as the principal's expected revenue and $E\pi_2$ as the agent's expected revenue. Then

$$\pi_1 = x - \alpha - \beta x = -\alpha + (1 - \beta)\pi,$$

$$\pi_2 = \alpha + \beta x - \frac{1}{2}be^2,$$

$$E\pi_1 = E(x - \alpha - \beta x) = -\alpha + (1 - \beta)e,$$

$$E\pi_2 = E(\alpha + \beta x - \frac{1}{2}be^2) = \alpha + \beta e - \frac{1}{2}be^2.$$

Assumption 5: Both the principal and the agent are risk aversion, each of them have an Arrow-Pratt risk aversion degree ρ_1, ρ_2 , $0 < \rho_1 < \rho_2$. According to literature Gao et al. (2008), the agent's risk cost equals $0.5\rho_2 \text{Var}(\pi_2)$. As we know, in the process of IT outsourcing, the principal

also confronts uncertainties and risks, furthermore, the principal's uncertainties mainly come from the uncertainties of the agent's final output. Hence, we assume that the principal and the agent face the same risk sources. Therefore we assume risk cost of the principal is $0.5\rho_1 \text{Var}(\pi_1)$. If both sides are risk aversion, their real income equals to expect revenue deducting the risk cost. After calculation, risk cost of the principal and the agent can be obtained respectively:

$$0.5\rho_1(1-\beta)^2\sigma^2, 0.5\rho_2\beta^2\sigma^2.$$

After the assumptions, the incentive model of IT outsourcing can be constructed as follows:

$$\text{Max}[-\alpha + (1-\beta)e - 0.5\rho_1(1-\beta)^2\sigma^2], \quad (1)$$

$$(IR)\alpha + \beta e - 0.5be^2 - 0.5\rho_2\beta^2\sigma^2 \geq \bar{w}, \quad (2)$$

$$(IC)e = \frac{\beta}{b}. \quad (3)$$

Formula (1) means the objective function of the maximum value of the principal's real income; Formula (2) means the agent's real income is at least more than his reserved income \bar{w} or his opportunity cost \bar{w} ; Formula (3) is the agent's participation condition.

2. MODELING ANALYSIS

Combining Formula (1), (2) and (3), we can figure out β^* , e^* . β^* represents the optimal output sharing proportion, and e^* means the optimal effort level.

$$\beta^* = \frac{1 + b\rho_1\sigma^2}{1 + b\rho_1\sigma^2 + b\rho_2\sigma^2}, \quad (4)$$

$$e^* = \frac{1 + b\rho_1\sigma^2}{b(1 + b\rho_1\sigma^2 + b\rho_2\sigma^2)}. \quad (5)$$

Proposition 1: The more the external uncertainties influence, the lower output sharing proportion and effort level are.

Proof:

$$\lim_{\sigma \rightarrow \infty} \frac{1 + b\rho_1\sigma^2}{1 + b\rho_1\sigma^2 + b\rho_2\sigma^2} = \frac{\rho_1}{\rho_1 + \rho_2}, \quad (6)$$

$$\frac{\partial \beta^*}{\partial \sigma} = \frac{-2b\rho_2\sigma(1 + b\rho_1\sigma^2)}{(1 + b\rho_1\sigma^2 + b\rho_2\sigma^2)^2} < 0. \quad (7)$$

Likewise, we can prove the bigger σ is, the lower effort level is. Because β^* and e^* are directly proportional relationship. Hence, they have the same variation tendency.

Proposition 1 gives us enlightenment: If there are many external uncertainties that are uncontrollable by the agent and can impact the final output, the optimal revenue sharing ratio and the agent's effort level will decrease. In that way, the principal can get more output sharing proportion and almost undertake all the outsourcing risk. At the same time, the lower effort level indicates the

vulnerable and inefficient motivation toward the agent. Namely, the more external uncertainties there are, the more risks the principal takes and the more output sharing proportion he gets and the worse the motivation is.

Proposition 2: The higher the risk aversion ρ_1 is, the bigger β^* and e^* are; the higher the risk aversion ρ_2 is, the lower β^* and e^* are.

Proof:

$$\frac{\partial \beta^*}{\partial \rho_1} = \frac{b^2 \rho_2 \sigma^4}{(1 + b\rho_1 \sigma^2 + b\rho_2 \sigma^2)^2} > 0, \quad (8)$$

$$\frac{\partial \beta^*}{\partial \rho_2} = \frac{-b\sigma^2(1 + b\rho_1 \sigma^2)}{(1 + b\rho_1 \sigma^2 + b\rho_2 \sigma^2)^2} < 0. \quad (9)$$

From Formula (8), (9), with the increasing of ρ_1 , the optimal sharing ratio β^* will increase correspondingly; with the increasing of ρ_2 , the optimal sharing ratio β^* will decrease.

Because β^* and e^* are directly proportional relationship, they have the same variation tendency. Likewise, we can prove with the increasing of ρ_1 , the optimal effort level e^* will increase and with the increasing of ρ_2 , the optimal effort level e^* will decrease.

Proposition 2 tell us: If the principal hates risks seriously, though he gets less output sharing proportion, the effort level of the agent will improve and motivation is relatively efficient; if the agent hates risks seriously, though he gets less output sharing proportion, he can alleviate his work load and decrease effort level.

Proposition 3: The bigger risk aversion of the principal is, the lower real income he gets; the bigger risk aversion of the agent is, the lower real income he gets.

Proof: from Formula (4), (5), we have known e^* , β^* , combine Formula (1), (2), we can get each real income as followings:

$$-\alpha + \frac{\rho_2 \sigma^2 (2 + 2b\rho_1 \sigma^2 - b^2 \rho_1 \rho_2 \sigma^4)}{2(1 + b\rho_1 \sigma^2 + b\rho_2 \sigma^2)^2}, \quad (10)$$

$$\alpha + \frac{(1 + b\rho_1 \sigma^2)^2 (1 - b\rho_2 \sigma^2)}{2b(1 + b\rho_1 \sigma^2 + b\rho_2 \sigma^2)^2}. \quad (11)$$

Formula (11) defines the real income of the agent. From (11) and the above assumption 1, α means fixed payment, it is a constant, economic man pursues maximum profits.

Therefore, only when $\frac{(1 + b\rho_1 \sigma^2)^2 (1 - b\rho_2 \sigma^2)}{2b(1 + b\rho_1 \sigma^2 + b\rho_2 \sigma^2)^2} > 0$, can the agent accept the outsourcing contract theoretically, or he will reject the contract. Hence, $1 - b\rho_2 \sigma^2 > 0$.

Calculate first-order derivative of ρ_1 of (10), we can get:

$$\frac{2b\sigma^2 [0.5b\rho_2 \sigma^2 (1 + b\rho_1 \sigma^2 - b\rho_2 \sigma^2) - (1 + b\rho_1 \sigma^2)]}{(1 + b\rho_1 \sigma^2 + b\rho_2 \sigma^2)^3}. \quad (12)$$

$$0 < \rho_1 < \rho_2, b\rho_2 \sigma^2 < 1 \Rightarrow b\rho_1 \sigma^2 < b\rho_2 \sigma^2 < 1 \Rightarrow 0.5b\rho_2 \sigma^2 (1 + b\rho_1 \sigma^2 - b\rho_2 \sigma^2) - (1 + b\rho_1 \sigma^2) < 0.$$

So value of Formula (12) is less than 0.

Likewise, calculate first-order derivative of ρ_2 of (11), we can get:

$$\frac{b\sigma^2 (b\rho_2 \sigma^2 - b\rho_1 \sigma^2 - 3)}{(1 + b\rho_1 \sigma^2 + b\rho_2 \sigma^2)^3}. \quad (13)$$

$$0 < \rho_1 < \rho_2, b\rho_2 \sigma^2 < 1 \Rightarrow b\rho_1 \sigma^2 < b\rho_2 \sigma^2 < 1 \Rightarrow b\sigma^2 (b\rho_2 \sigma^2 - b\rho_1 \sigma^2 - 3) < 0.$$

So value of formula (13) is less than 0.

Proposition 3 tells us the relationship between the risk aversion and their real income.

Proposition 4: The bigger the cost coefficient, the less real income the principal can get.

Proof: Calculate first-order derivative of b of (10), we can get:

$$-\frac{2b\rho_1^2 \sigma^4 + 2b\rho_1 \rho_2 \sigma^4 + 2\rho_1 \sigma^2 + 4\rho_2 \sigma^2}{(1 + b\rho_1 \sigma^2 + b\rho_2 \sigma^2)^3} < 0. \quad (14)$$

As the first order derivative is less than 0, therefore bigger the cost coefficient, the less income.

Proposition 4 tells the necessity for the principal to cooperate with qualified partners.

CONCLUSIONS AND DISCUSSIONS

The paper mainly analyzes information technology outsourcing incentive problems of both principal and the agent's risk aversion under unilateral moral-hazard. The conclusions are as following: Firstly, the more the external uncertainties influence, the lower output sharing proportion and effort level are; secondly, the bigger risk aversion of the principal is, the lower real income he gets; the bigger risk aversion of the agent is, the lower real income he gets; thirdly, the bigger the cost coefficient of the agent is, the less real income the principal can get.

The discussions are as following. Firstly, traditional outsourcing incentive problems mainly explore the adjustment of effort level and output sharing proportion to achieve the motivation toward the agent. Therefore, the key is to balance the relationship of the effort level and the sharing ratio. As there are always uncertainties in the market, it is inevitable to avoid risks. The more the uncertainties influence, the lower output sharing ratio and effort level are. Though uncertainties are uncontrollable, this is the balance mechanism and can ensure the agent to fulfill the contract. Secondly, risk aversion measures the attitude toward risk. When both risk aversion is very high, their real income will decrease. In fact, high risk aversion means the principal and the agent hate risks and pursue secure income. As

we known, income is always along with risks. The more one avoid risks and the more secure he pursues, the less he obtains actually. Finally, it is very necessary for the principal to cooperate with qualified partners because the agent's cost coefficient is directly negatively related to his income.

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