SPECIAL INVESTMENT, OWNERSHIP – HOLDING ARRANGEMENT AND INCENTIVE EFFICIENCY: A THEORETICAL MODEL ANALYSIS ON OWNERSHIP BONDING WITHIN ENTERPRISE GROUP

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Abstract

A theoretical explanation for partial ownership arrangement existing among group members is provided under the background of specific investment between vertical suppliers and buyers. Through installing specific investment degree parameter, relative bargaining capability parameter, outside option value parameter and average premium (discount) price coefficient into the same model framework, some major conclusions are obtained about the relations between the first-best partial ownership and those parameters. In final, the interrelations between the first-best partial ownership and special investment efficiency are discussed, and it's pointed out that under the conditions of the same technical parameters, the investment efficiency in the case that the upstream firm belongs to public-company type is greater than that in the case of the owner-managed company type.

Keywords: special investment, partial ownership, models

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1. Introduction

The transaction relationships among two or more member-firms within a firm group form a complex network, in which the cooperation is quite thorough and formal[18]. In Richardson's viewpoint, two cooperative parties must not only accept the duty to a certain degree for their future behaviors, but also should be provided with a guarantee to a certain degree, long-term contracts or equity participation methods become a quite formal cooperation arrangement(Richardson,1972). Many of the inter-firm research and development (R&D) collaboration in the United States among small biotechnology firms and established pharmaceutical companies are cemented by equity participation (Pisano,1989) . In Japan, it is well documented that the automakers hold minority equity ownership in their parts suppliers and that the suppliers make substantial investments specific to their automakers (Aoki,1988; Dyer and Ouchi,1993) .In fact, these features have been suggested as some keys to the success of the Japanese automobile industry. For above mentioned cooperation transactions, why is equity participation adopted rather than cooperative arrangement of long-term contracts? That is exactly the transaction efficiency paradox of the different cooperative arrangement ways that we want to investigate.

In realistic transactions, because the complexity, uncertainty of future affairs and traders' bound rationality coexist at the same time, it is impossible to consider all the related variables or implausible due to too expensive costs spent in considering them. The incompleteness of contract reduces its value. Knowing that incomplete contracts can't resolve the "*hold-up*" problem of opportunists(Che,1999) , under the backgrounds of opportunism, assets specificity, incomplete contracts and future's uncertainty, various organizational interventions are proposed to solve the "hold-up" problem, such as vertical integration, exchange hostages, shifting property rights, and designing an authority relationship(Williamson,1983; Hart and Moore,1988; Grossman and Hart,1989). Cooperative transaction among member-firms within a firm-group may lose efficiency because of *ex post* opportunistic behavior caused by the specific investment or outside options. Williamson and Klein persist that, it is very likely that the specific investment in the transaction can't achieve the first-best outcome under the expectation of *ex post* opportunistic behaviors. Vertical integration instead of the spot market can avoid or reduce the opportunistic behaviors caused by assets specificity. The final choice is made based on the comparison of the trading costs of two kinds of cooperative mechanism (Williamson,1985; Klein , Crawford and Alchian,1978) .

However, integration (internal transaction) is not always better than market transaction, which means that it would lead to efficiency loss when all

[18] Cooperations among member-firms usually occur in the framework provided by subcontracts, also exists among the firms which tie with each other on the manufacturing and marketing facets, the cooperative arrangements for technical sharing and technical transfer have become the important cooperative ways in recent decades.

productive activities are arranged in the integration organization. Why can't the market relation among independent entities be replaced fully by integration? Williamson's replace model provides the reasons for avoiding integration: (1) if firms manufacture inputting products by themselves, the economy of scale and the economy of scope may be lost. (2) When the degree of assets specificity is low, the governing costs of internal organizations will be greater than that of market organizations (Williamson,1985) . When analyzing the disadvantage of the governing costs of internal organizations, the interpretation of the loss of control rights and the failure of selective optimal intervention are convincing. Based on the criticism and inheritance of existent theories, Milgrom and Roberts (1992) propose that the costs of political activities within the organization is an important obstacle of the collection of control rights, which interprets the inside transaction within integration organizations is not always better than the market transaction among entities from the aspect of non-market transaction costs. The limitations of integration organizations indicates that the single model of integration among the parent firm and member-firms is not the first-best, and the concurrence of various bonding relationships within the firm group is the feasible choice of the decision-maker when constructing a firm group.

With cooperation transactions among firms increasing quickly, the share-holding arrangement (partial ownership) becomes an important cooperative institution arrangement. However, there are very few theoretic researches aiming at equity participation phenomena (especially within firm groups). The conventional wisdom is that partial ownership, by reducing opportunism, helps promote the bonding between the upstream and downstream firms through encouraging greater specific investment (Che ,1999;Williamson,1983; Hart and Moore,1988; Grossman and Hart,1989) . In the absence of contractual remedies, equity participation perhaps may play a role instead. However, under symmetric information, equity participation by a downstream firm in an upstream supplier has no effect on the payoffs when the parties bargain to divide the benefits of specific investment (Hart and Moore,1988). In view of this, the role of partial ownership in promoting bonding remains unclear.

In the models suggest by Bolton & Whinton (1993) and Rajan &Zingales (1998), the problems of the optimal ownership allocation are discussed in details, but these models only mention the efficiency problem of integration organization, and ignore the efficiency-enhancing problem brought in by the cooperative mechanism of partial ownership. Different from their models, our models focus on demonstrating the partial ownership role of specific investment which is used to motivate investors, and simultaneously, obtaining the reason why the whole ownership is not possibly optimal.

Dasgupta and Tao(2000) provide the theoretic interpretation of the partial ownership phenomena, whose models are based on the selective decision made by the upstream firms between alternative investment strategies. They consider two types of investment, in which the specific investment degree parameter a=0 and a>0. When the potential income of investment is random, that the downstream firm holds partial ownership of the upstream firm can render the upstream firm to choose more efficient investment type than the simple contract. Comparing with Aghion and Tirole's (1994) mechanism arrangement theory of innovative ownership, the former's theory interpretation on partial ownership is more profound, they not only agree with the viewpoint that the relative bargaining power of the trade parties will affect the efficiency of the ownership allocation, but also install the bargaining power parameter into the models and obtain the correlations between the connected parameters and the magnitude of partial ownership. When the downstream firm is in the decision-making reality of equity participation, the optimal partial ownership is not only the credible commitment that can incentive the upstream firm to choose specific investment of higher level, but also the mechanism arrangement of maximizing the benefits of the downstream firm, which means that the downstream firm whose target is to maximize its benefits doesn't have to choose the equity participation ratio that can motivate the upstream firm to make the full specific investment□a=0□. Hence, viewing a as a variable that the upstream firm can choose may meet the realistic condition better. We also insist on that, at a given investment level, it is rational that the potential income of the investment is assumed to increase with the increase of the specific investment degree.

In addition, we suggest that, the existence of partial ownership affect investment and the success probability of obtaining the outside option income slightly. Dasgupta etc. mention that the partial ownership would lower the diligence expenditure of the upstream firm's entrepreneur, but neglect the supervisory effects caused by the downstream firm's equity participation. Hence, in fact, partial ownership won't change the diligence expenditure of decision-makers evidently. Once investment is made, both the investment income and the outside option income are supposed to be realizable.

Besides analyzing the case of the owner-managed upstream firms, our model also involves the case of the public-firms managed by professional managers. Very obviously, the decision-makers of these two kinds of firms have so many differences between their investment decision behaviors that we should probe into them separately.

The rest of this paper is organized as follows: In Section 2 we outline the model, analyze the limitations of the simple contract. Section 3 analyses the equity participation problem of the owner-managed upstream firms. Section 4 discusses the first-

best partial ownership problem of the publicly traded upstream firms. Section 5 analyses the effects of the first-best partial ownership on the efficiency of the specific investment. Conclusions appear in Section 6.

2. The Basic Models

2.1 Technical Parameter Assumptions

Assuming the member-firms ***s*** and ***b*** within the group are respectively the upstream firm (seller) and downstream one (buyer) in a transaction. The two parties can make the specific investment bilaterally or unilaterally. Without loss of generality, we assume that ***s*** can make the unilateral specific investment, which can increase the final products' value of the downstream firm. The upstream firm can be owner-managed firms, or can be public-firms run by professional managers. Here, we call the owners of owner-managed firms as entrepreneur, and call the decision-maker of the publicly traded firm as the manager. It is assumed that the downstream firm ***b*** is run by professional manager in the interest of the stockholders□the owner-managed downstream firm won't affect our analyses□. Unless specially pointed out, ***s*** is assumed as an owner-managed firm in our analyses. In addition, all players are assumed to be risk-neutral.

For simplicity of the analyses and the generalization of models, three time periods are considered, that is , ***t***=0,1, 2. At ***t***=0 ,the downstream firm offers to buy a fraction *r*[0, 1] of the upstream one at price *P(r)*, the entrepreneur can accept or reject the offer.

At ***t***=1, the entrepreneur chooses the specific investment degree parameter ***a*** based on the potential value ***V(a)*** and the cost function ***C(a)*** of the specific investment, where *a*[0, 1]. Smaller ***a*** means the higher investment specificity degree for buyer .Assuming that *V(a)* and *C(a)* are common knowledge, and acquirable information of the two trade parties.

For the characters of ***V(a)*** and ***C(a)***, we make the following assumptions:

ASSUMPTION 1: $\forall a \in [0,1]$ assuming $V'(a)(C'(a))$ and $V''(a)(C''(a))$ are the first–order derivative and the second-order derivative of $V(a)(C(a))$ in a respectively. And there exists:

(i) $V(a) > 0$ and $C(a) > 0$,

(ii) $V'(a) < 0$ and $C'(a) < 0$,

(iii) $V''(a) < 0$ and $C''(a) > 0$.

The above assumptions make sure that the net revenue function of specific investment *[V(a) - C(a)]* is concave, which accords with the rational assumption of the specific investment behavior. At ***t***=2, *V(a)* and *C(a)* are realized. *V(a)* and *C(a)* are common knowledge, but they can't be verified, so the contract can't be consigned on this.

Then, we consider that at ***t***=0, seller and buyer signs a take-or-pay simple contract[9], *(P_T, P_N)* is the payoff portfolio the downstream firm will pay to the upstream one in two cases when trade in the contract occurs or not. At ***t***=2,the upstream firm face renegotiation with the downstream one bilaterally, if the renegotiation between seller and buyer failed, seller will make the trade with other downstream firm, the potential value of the investment will be changed into *aV(a)*.

Assuming that the relative bargaining power of the downstream firm is denoted by λ, then that of the upstream firm is (1-λ), where λ[0, 1]. We incorporate the analyses of surplus distribution in two cases of trade and non-trade into the framework of the Nash Bargaining Solutions. By backward deductive method, That *(P_T, P_N)* can be renegotiated at ***t***=2 shows, *(P_T, P_N)* should obey the constraints of the Nash Bargaining Solution.

Under what condition the simple contract *(P_T, P_N)* can lead to the optimal incentive outcome, and under what condition equity participation arrangement can enhance more efficient investment are what we will mainly probe into.

2.2 Simple Contract and Investment Choice

Given simple contract *(P_T□P_N)* and the equity participation ratio ***r*** of buyer, the payoff matrix of two trading parties is as follows in two cases when the negotiation is either successful(*T*) or failed (*N*):

	s	*b*
T	$(1-r)[P_T - C(a)]$	$V(a) - P_T + r[P_T - C(a)]$
N	$(1-r)[P_N + av(a) - C(a)]$	$r[P_N + av(a) - C(a)] - P_N$

In the game model of the repeat bargains, the Nash bargaining solutions require that contract *(P_T, P_N)* satisfy:

$$\max\{(1-r)[P_T - C(a)] - (1-r)[P_N + av(a) - C(a)]\}^{1-\lambda} * \{V(a) - P_T + r[P_T - C(a)] - r[P_N + av(a) - C(a)] + P_N\}^{\lambda} \quad (1)$$

The first order condition of P_T demands,

$$\frac{(1-\lambda)(1-r)}{(1-r)[P_T - P_N - av(a)]} + \frac{\lambda(r-1)}{v(a) - P_T + r[P_T - P_N - av(a)] + P_N} = 0 \quad (2)$$

Then

$$P_T = \frac{[1 - ar + (a-1)\lambda]v(a)}{1-r} + P_N \quad (3)$$

Using the payoff matrix of seller and buyer, , the revenue of seller and buyer are *(1- r)[P_T -C(a)]* and *[V(a)-P_T+r(P_T- C(a))]* respectively□denoted by $S_T(r, P_N)$and $B_T(r, P_N)$ respectively when transaction occurs. So we have

$$S_T(r, P_N) = [1 - ar - (1-a)\lambda]V(a) + (1-r)[P_N - C(a)] \quad (4)$$

$$B_T(r, P_N) = [ar + (1-a)\lambda]V(a) - (1-r)P_N - rC(a) \quad (5)$$

The optimal social investment choice must satisfies

$$\max_a [V(a) - C(a)] \quad (6)$$

The first order condition demands,

$$V'(a) = C'(a) \quad (7)$$

That is, the first-best specific investment degree parameter $a_{fb} = \arg[V'(a) = C'(a)]$.

But, if r=0, can (P_T, P_N) make sure that the entrepreneur chooses α_{fb}?

For simplicity of the analyses, let P_N=0, then that the manager chooses a^* to maximize the revenue demands

$$a^* = \arg\max_a S_T(r, P_N) \quad (8)$$

Simplified, we have

$$[1-a^*r-(1-a^*)\lambda]V'(a^*)+(\lambda-r)V(a^*)-(1-r)C(a^*)=0 \quad (9)$$

When r=0,the above equation can be changed into:

$$[1-(1-a^*)\lambda]V'(a^*)-C'(a^*)+\lambda V(a^*)=0 \quad (10)$$

$$\because \quad -(1-a^*)\lambda V'(a^*)+\lambda V(a^*)\geq 0, \text{ then } V'(a^*)-C'(a^*)\leq 0 \quad (11)$$

The function $[V(a)-C(a)]$ is concave, so

$$a^* \geq a_{fb} \quad (12)$$

It means, when the entrepreneur of the upstream firm has the complete bargaining power (λ=0), the simple contract (P_T, P_N) can induce the entrepreneur to choose the optimal investment specificity level. But when $\lambda > 0$, (P_T, P_N) can not guarantee that the entrepreneur will make the choice of efficient investment.

No difficult to understand, when the entrepreneur who has the complete bargaining power can obtain the whole investment surplus, he or she will make the choice of the fist-best efficient investment. It accords with the interpretation of Chung(1991), Aghion & Tirole (1994), Dasgupta and Tao(2000) that the incomplete contract can also lead to efficient outcomes.

When $\lambda > 0$, can installing the exterior variable r lead to efficient outcomes? We can Change Equation (9) into:

$$[(1-\lambda)+(\lambda-r)a^*]V'(a^*)-(1-r)C'(a^*)$$
$$+(\lambda-r)V(a^*)=0$$

If $a^*=a_{fb}$, then $V'(a^*)=C'(a^*)$.This means:

$$(\lambda-r)[(a^*-1)V'(a^*)+V(a^*)]=0 \quad (13)$$

Obviously, $(a^*-1)V'(a^*)+V(a^*)>0$, so only when $r=\lambda$, Equation (13) may hold. Since $P_T=V(a_{fb})$, then $(P_T,P_N)=(V(a_{fb}), 0)$.

Integrating the above analyses, we can conclude:

PROPOSITION 1: (i). When the entrepreneur has the complete bargaining power, the simple contract $(V(a_{fb}), 0)$ can render the entrepreneur to choose the socially optimal investment level (ii). When $\lambda>0$, the efficient investment outcome can be obtained only by equity participation $r=\lambda$ and the simple contract $(V(a_{fb}),0)$.

Proposition 1 doesn't mean the downstream firm b must make the decision of equity participation $r=\lambda$ at t=0, because as a rational entity maximizing its benefit, the downstream firm does not only have to consider the specific investment efficiency of the investor, but also have to consider the costs of equity participation. Hence, the optimal equity participation ratio may dissatisfy the condition under which the manager would choose the socially optimal investment type. In next section, we'll discuss the problem about optimal equity participation ratio.

3 Equity Participation by the Downstream Firm in the Upstream Owner-managed Firm

This section aims at obtaining the comparative static outcome affecting the equity participation ratio factors, so we will install the cost items related to the equity participation in order to obtain the internal angle solution about the optimal partial ownership.

3.1 Optimal Equity Participation Ratio

Given r, entrepreneur will choose a^* to maximize the investment earnings, that is

$$a^* = \arg\max_a S_T(r)$$

Expecting at t=1, entrepreneur will choose a, the manager of the downstream firm will, at t=0, make a decision on optimal equity participation ratio r to maximize its total net income. As we all know, under the mechanism of partial ownership the downstream firm can obtain the advantages of the efficient investment, but must pay for the cost of obtaining the ownership. The reason why complete vertical integration is not always the optimal choice is that the integration cost is likely to exceed the added-value of this cooperative arrangement.

Assuming other outside income of the upstream firm is π_0, we express $P(r)$ that the downstream firm pays for a fraction r of the upstream firm in the following equation:

$$P(r) = (1+\beta)[(S_T(o)+\pi_0)-(S_T(r)+(1-r)\pi_0)]$$

In this equation, $(S_T(o)+\pi_0)$ term represents total income of the entrepreneur when r =0, and $(S_T(r)+(1-r)\pi_0)$ is the corresponding revenue that the entrepreneur earns when the equity participation ratio is r. The difference between these two terms can be regarded as the real value of the equity fraction r of the upstream firm. Let β denote the average premium (discount) price coefficient at which the downstream firm acquires a fraction r of the upstream firm, where $\beta>0$ represents purchasing at premium, $\beta=0$ represents purchasing at par, $\beta<0$ represents purchasing at discount, That we install β - coefficient into the formula calculating $P(r)$ accords with the facts of equity disputing.

Let π_d denote net income of the downstream firm, then

$$\pi_d = B_T(r) + r\pi_0 - P(r) \quad (14)$$

Substituting $B_T(r)$ and $P(r)$ into the above equation, we get

$$\pi_d = V(a) - C(a) + \beta S_T(r) - \beta\pi_0 r - (1+\beta)S_T(o) \quad (15)$$

Expecting the entrepreneur choose a^* according to equity participation ratio r, that is, $a^* = a^*(r)$, the manager of the downstream firm will buy optimal equity ratio r^* to maximize π_d, that is

$$r^* = \arg\max_r \pi_d$$

The first order condition demands,

$$\frac{\partial a^*}{\partial r}[V'(a^*) - C'(a^*)] + \beta[C(a^*) - a^*V(a^*)] - \beta\pi_0 = 0 \quad (16)$$

Without loss of generality, assuming $C(a_{fb})$-$a_{fb}V(a_{fb}) \le 0$, we will discuss the results in the cases of different β-value .

(1) $\beta > 0$, which means purchasing at premium.

By Equation (9), we know

$$\frac{\partial^2 S_T(r)}{\partial (a^*)^2} < 0 \cdot$$

But , $\frac{\partial^2 S_T(r)}{\partial a^* \partial r} = -a^*V'(a^*) - V(a^*) + c'(a^*)$

$$= -a^*V'(a^*) - V(a^*) + \frac{1 - a^*r - (1-a^*)\lambda}{1-r}V'(a^*) + \frac{\lambda - r}{1-r}V(a^*)$$

$$= \frac{(1-a^*)(1-\lambda)}{1-r}V'(a^*) - \frac{1-\lambda}{1-r}V(a^*) < 0$$

Thus, $\frac{\partial a^*}{\partial r} = \frac{-\partial^2 S_T(r)/\partial a^* \partial r}{\partial^2 S_T(r)/\partial (a^*)^2} < 0$

Since $V'(a^*) - C'(a^*) < 0$,if β is sufficiently smaller then

$$\frac{\partial \pi_d}{\partial r}|_{r=0} > 0$$

.Similarly, $\frac{\partial \pi_d}{\partial r}|_{r=\lambda} = \beta[C(a_{fb}) - a_{fb}V(a_{fb}) - \pi_0] < 0 \cdot$

Thus, the optimal partial ownership $r^*(0, \lambda)$, and we can get $a^* > a_{fb}$.

If β is sufficiently larger, $\forall r \in [0,1]$, $\frac{\partial \pi_d}{\partial r} < 0$, then $r^* = 0$.

(2) $\beta = 0$, which means purchasing at par.

Obviously, that Equation (16)holds requires

$$V'(a^*) - C'(a^*) = 0$$

Then , $r^* = \lambda$, and $a^* = a_{fb}$.

(3) $\beta < 0$, which means purchasing at discount.

Evidently, when the value of the upstream firm is underestimated, the downstream firm will buy as much equity as possible to maximize its total net income. Although over-incentive effects of equity may lead to investment specificity level exceeding the social optimality, the increase of the equity investment revenue renders the manager of the downstream firm to purchase the share greatly exceeding the social optimal level, that is , $r^* > \lambda$. Besides, with the share-holding ratio of the downstream firm exceeding the entrepreneur's, the investment specificity level of the upstream firm should equal that of the social optimal investment type. So, we have

$$a^* \begin{cases} = a_{fb} & if\ r^* \ge 1/2 \\ < a_{fb} & if\ r^* < 1/2 \end{cases}$$

If β is sufficiently negative ,then $r^*=1$, and $a^*=a_{fb}$. Notably, we regard β as a constant in this paper, which doesn't affect our analyses about the optimal equity participation ratio. But what we must pay attention to is that, with r increasing and decreasing, average discount (or premium) price parameter β may be mutative. The exact magnitude of the optimal partial ownership will depend on β-value. For example, assuming with r increasing, average discount price parameter β will be changed from negative value into positive value, at the same time, the increasing trend of r^* will stop, $r^*<1$. Of course, if β is changed from positive into negative, the outcome will be just the opposite. In fact, β can be regarded as the discrete function of r with non-regular distribution .Just because of this, in our analyses, we don't regard β as the function of r in technical processing, but discuss it as a constant item, which is beneficial to our model conclusions and without loss of reliability.

Concluding the above analyses, we get,

PROPOSITION 2:

(i) If β is sufficiently smaller positive value, $C(a_{fb})$ - $a_{fb}V(a_{fb}) \le 0$, the downstream firm owns the optimal partial equity of the upstream firm $r^*(0, \lambda)$, the investment specificity level which the entrepreneur chooses is below social optimal level, that is, $a^* > a_{fb}$. If β is sufficiently larger, choosing $r^*=0$ will be beneficial for the downstream firm.

(ii) In the case when purchasing at par ($\beta=0$), $r^* = \lambda$ and $a^* = a_{fb}$ hold, and the efficient investment outcome can be obtained.

(iii) In the case when purchasing at discount, $r^* > \lambda$ and $a^* \le a_{fb}$ hold, optimal partial ownership can motivate the entrepreneur to choose social optimal investment type.

Proposition 2 demonstrates that, only when purchasing at par, optimal equity participation mechanism can guarantee the most efficient outcome is obtained. When purchasing at premium or discount price, the distortion effects of the wealth transfer will make the investment outcome brought up by optimal partial ownership deviate from social optimal investment type.

According to Proposition 2, we can interpret that, under the condition of the same technology, the reason why the average equity ratios Japanese manufacturing firms hold of part suppliers' partial ownership exceed the corresponding value of American firms. In Japan, majority equity ownership of the firms is under the control of minority artificial persons' shareholders or institution investors, the exchange ratio of the stock is very low, and the exchange of stock is often solved by private negotiation. Generally, in this case, $P(r)$ will not deviate seriously from its real value, β is likely to exceed zero a little. But in the United States, whose capital markets are very mature, equity ownership of firms is widely dispersed, the public shareholders hold the majority equities, the ownership r is obtained by exchange in the stock market, the bids of many trade entities leads to β-value exceeding zero greatly(Xingmin Yin,1999; Weston, Chung and Susan,1998). Therefore, when other technical parameters are not changed, the mechanism that the greater β-value would result in the smaller r^* results in the inter-firm equity participation ratio in Japan to be obviously higher than the corresponding value of the same industry in the United States.

In China, the modern firm governance mechanism reform just began, the ownership partition of many firms is unclear, and many social functions firms are responsible for are not peeled off. The high premium price acquisitions may make the downstream firm choose r^*=0, which leads to the under-motivation of the specific investment of the upstream firm, and the social optimal investment outcome can't be realized. A practical example is shortage of the specific investment by the smelting firms in the mine suppliers. That the social optimal investment by the smelting firms in the mine suppliers can reduce the productive costs of the smelting firms, maximize the two parties' common profits. However, the workers of most mines are superfluous, the social burdens are heavy, and the equity participation of the smelting firms can not come into a reality because of too high premium price. As a result, the mine suppliers will not make the social optimal specific investment. Therefore, in the developing process of firm groups in China, it is necessary that the firms become the entities that can be self-managed, self-constricted and self-motivates, and the burden of the social functions will lead to the loss of the trade efficiency, which are all what we must pay attention to.

3.2 Comparative Static Analysis Outcomes

The solution of the optimal partial ownership can be applied to obtaining the comparative static analyses about the factors which affect equity participation realities. When specific investment is implemented, the *ex post* bargaining problem and the investment specificity degree become two key factors leading to latent "hold-up" problems. Generally spoken, the larger the probability of "hold-up" is, the stronger the motivation of inducing integration becomes. Therefore, the severe degree of the *ex post* bargaining problem (or the so-called "small-number bargaining problem") reflected by the relative bargaining power parameter λ of downstream firms affects the complete degree of integration. Just as we will demonstrate below, the optimal partial ownership is closely related to the relative bargaining power.

PROPOSITION 3: If $\beta > 0$ and is sufficiently smaller, then the optimal partial ownership by the downstream firm in the upstream owner-managed firm is positively related with its relative bargaining power.

Proof: by $\dfrac{\partial \pi_d}{\partial r \mid r = r^*} = 0$, we have

$$\frac{\partial r^*}{\partial \lambda} = \frac{-\partial^2 \pi_d / \partial r \partial \lambda}{\partial^2 \pi_d / \partial r^2}$$

Now that the second -order concave function condition of π_d in r^* is satisfied, thus

$$\frac{\partial^2 \pi_d}{\partial r^2} < 0$$

Therefore, $Sign(\partial r^* / \partial \lambda) = Sign(\partial^2 \pi_d / \partial r \partial \lambda)$

By Equation (16), we get

$$\partial^2 \pi_d / \partial r \partial \lambda = [\partial a^* / \partial r][V''(a^*) - C''(a^*)][\partial a^* / \partial \lambda] + [\partial^2 a^* / \partial r \partial \lambda][V'(a^*) - C'(a^*)] + \beta[C'(a^*) - V(a^*) - a^* V'(a^*)][\partial a^* / \partial \lambda] \quad (17)$$

And by Equation(9), we know

$$\frac{\partial a^*}{\partial \lambda} = -[\partial^2 S_T(r) / \partial a^* \partial \lambda] / [\partial^2 S_T(r) / \partial (a^*)^2]$$

Since $\partial^2 S_T(r) / \partial (a^*)^2 < 0$, deduced from the second-order condition of $S_T(r)$, then

$$Sign(\partial a^* / \partial \lambda) = Sign[\partial^2 S_T(r) / \partial a^* \partial \lambda]$$

And, $\because \partial^2 S_T(r) / \partial a^* \partial \lambda = (a^* - 1)V'(a^*) + V(a^*) > 0$

$\therefore \partial a^* / \partial \lambda > 0$

Similarly, we can prove

$\partial^2 a^* / \partial r \partial \lambda < 0$ and $\partial^2 a^* / \partial r^2 < 0$.

By $\partial^2 \pi_d / \partial r^2 < 0$,we know

$$[\partial a^* / \partial r][V''(a^*) - C''(a^*)] + \beta[C'(a^*) - V(a^*) - a^* V'(a^*)] > 0$$

Therefore, $\partial^2 \pi_d / \partial r \partial \lambda > 0$.

Hence, $\partial r^* / \partial \lambda > 0$ .That is, the optimal partial ownership r^* increases with the increase of the relative bargaining power.

Under the framework of our models, the conclusion of Proposition 3 is very intuitive. Given equity participation ratio r , the investment specificity degree that the entrepreneur chooses decreases with the increase of the relative bargaining power λ of the downstream firm. To offset the trend, the downstream firm must enlarge the equity participation ratio, which will reduce the returns the entrepreneur earns from the investment of low specific degree. According to our

models, we can predict that, when there are other replaceable upstream suppliers, that is, the downstream firm has more bargaining power, the entrepreneur has stronger motivation to choose low-efficient investment specific degree in advance. To support efficient specificity investment choice, the downstream firm is to hold more partial ownership in the upstream firm. Japanese automakers own high ownership of their main part suppliers, which accords with the expecting conclusion of our models.

Japanese automakers do not only trade with a few part suppliers, but also provide the input products by themselves. Once the suppliers make the specific investment, automakers will own great bargaining power because of the existence of several replaceable suppliers. For main suppliers, because their supply percents are very large, just so-called "the boat is too large to run back", the very small probability of shifting their manufacturers leads to their weak place in the bargaining. So these main suppliers are apt to choose the low specificity investment level. Only if automakers enlarge their equity participation ratio, they can ensure the more efficient investment outcome to be obtained.

Except that the *ex post* bargaining problem affects the magnitude of the optimal partial ownership, outside income π_0 influenced by premium price coefficient directly relates to the cost of purchasing partial ownership, plays another important role in deciding on the optimal partial ownership. In view of this, it is necessary to analyze the relationship between the optimal partial ownership and the outside income π_0.

Similar to the proof process of Proposition 3, we will provide analyses of the relation between r^* and π_0.

According to the comparative static technical method, we know

According to the comparative static technical method, we know

$$\partial r^*/\partial \pi_0 = -(\partial^2 \pi_d/\partial r \partial \pi_0)/(\partial^2 \pi_d/\partial r^2)$$

By $\partial^2 \pi_d/\partial r^2 < 0$ we get

$$Sign(\partial r^*/\partial \pi_0) = Sign(\partial^2 \pi_d/\partial r \partial \pi_0)$$

And $\partial^2 \pi_d/\partial r \partial \pi_0 = -\beta$ thus

$$\frac{\partial r^*}{\partial \pi_0}\begin{cases} > 0 & if\ \beta < 0 \\ = 0 & if\ \beta = 0 \\ < 0 & if\ \beta > 0 \end{cases} \quad (18)$$

According to Equation (1), we can come into the conclusions below:

PROPOSITION 4: Assume that the optimal partial ownership *r** by the downstream firm in the upstream owner-managed firm has an internal angle solution. Then

(i) when purchased at discount, r*is positively correlated with π_0;

(ii) when purchased at par, r^* is independent of π_0;

(iii) when purchased at premium, r^* decreases with π_0 increasing.

Generally spoken, the equity premium purchase is very prevalent, that is $\beta > 0$. The optimal ownership is negatively related with π_0, which means the larger the outside income is, the higher the equity participation cost by the downstream firm becomes. In the case of premium price, the negative correlation between r^* and π_0 can be proved by the reality of the equity participation by the Nissan Company in its part suppliers(Dyer and Ouchi ,1993; Asanuma ,1989) . Calculating by the percentage of the direct sale to Nissan Company over their total sale, for the three suppliers the ratios of which are at the top (average 71%), the average share-holding ratio holding by Nissan Company is 37.7%. For the three suppliers the ratios of which are in the middle (average 47%), the average share-holding ratio holding by Nissan Company is 33%. And for the three suppliers the ratios of which are the least (average 24%), the average share-holding ratio holding by Nissan Company reduces to 26%. Therefore, with the increase of the outside trade income of the upstream firm, the share-holding ratio by the downstream firm in the upstream firm has a decreasing tendency.

Specially, when market value of the upstream firm is severely underestimated or some other discount price events occur, the downstream firm is apt to purchase majority or all of ownership of the upstream firm. We persist that, this share-holding behavior is not for strengthening the bonding of the trade entities to render the entrepreneur to choose efficient specific investment level, but for maximizing its own income. A series of assets reorganization behaviors in which the object firms were peeled off after buyout support our viewpoint.

Besides λ and π_0, β is also a key factor affecting r^*. We have mentioned this point in last section. Especially to note, $r^*$is a decreasing function in β, all conclusions of the relation among r^*, λ and π_0 are all constructed on the existence of r^*'s internal anger solutions. In later analyses, if not specially pointing out, conclusions we would come into contain such a premise.

4. Equity Participation by the Downstream Firm in the Upstream Public-Firm

In this section, we will expand our analyses of the optimal partial ownership to the public firm (firms operated on by professional managers). When the upstream firm is not owner-managed but a public-firm, the analyses of last section do not apply completely, in that professional managers in the interest of the stockholders will not be affected directly by the dispersive equities, when calculating investment income. Even so, our analyses below demonstrates that partial ownership still affects the

investment choice of managers, and a conclusion similar to last section will be obtained.

For simplicity of analyses, except assuming that managers of upstream firms are risk neutral, we also assume that there exists no manager's moral hazard about reward compensating mechanism and endeavor choice problem. Assume that rewards of managers are a minority part of the whole profit of upstream firms, which make sure managers make decisions in the interest of the stockholders. Based on these assumptions, we can attain the bargaining outcome below.

LEMMA 1**:** Given $\boldsymbol{r}$ and $\boldsymbol{\lambda}$, and let P_N=0, so the downstream firm pays

$$\hat{P}_T = \frac{[1-ar+(a-1)\lambda]V(a)}{1-r}$$

to the upstream public-firm.

And the incomes obtained by the two trade parties are, respectively,

$$\hat{\boldsymbol{S}}_{\boldsymbol{T}}(\boldsymbol{r}) = \frac{[\boldsymbol{1-ar-(1-a)\lambda}]\boldsymbol{V(a)}}{\boldsymbol{1-r}} - \boldsymbol{C(a)}$$

$$\hat{\boldsymbol{B}}_{\boldsymbol{T}}(\boldsymbol{r}) = [\boldsymbol{ar+(1-a)\lambda}]\boldsymbol{V(a)} - \boldsymbol{rC(a)}$$

From the payoff matrix of two trade parties, we can obtain $\hat{P}_T = P_T$ □that is, no matter what type the upstream firm belongs to, the payoffs of the downstream firm are the same. There exist differences between two upstream firm type's trade income function. But for the downstream firm, the function form of the trade income keeps unchanged.

Observe that the manager of the upstream firm will choose the investment specific degree $\hat{a}^*$ to maximize its utility, given the manager's risk neutrality, we know

$$\hat{a}^* = \arg[\partial \hat{S}_T(r)/\partial a = 0] \qquad (19)$$

Knowing given *r*, the manager would choose $\hat{a}^*(r)$ to maximize the earnings of the upstream firm, decision-makers of the downstream firm can decide on equity participation ratio to maximize its net income $\hat{\pi}_d$. Here, we adopt the form below to describe $\hat{\pi}_d$:

$$\hat{\pi}_d = \hat{B}_T(r) + r\pi_0 - \hat{P}(r) \qquad (20)$$

Where, $\hat{P}(r)$ denotes the price at which the downstream firm buy a fraction $\boldsymbol{r}$ of equity of the upstream firm. Assuming the faction $\boldsymbol{r}$ of equity is purchased through tender offers, the real value $\delta(r)$ of the upstream firm based on the partial ownership *r* can be expressed as:

$$\delta(r) = \hat{S}_T(r) + \pi_0$$

P(*r*) can be denoted as follows:

$$P(r) = (1+\beta)r\delta(r) \qquad (21)$$

Therefore, the total net income of the downstream firm can be described as:

$$\hat{\pi}_d = \hat{B}_T(r) + r\pi_0 - r(1+\beta)[\hat{S}_T(r) + \pi_0] \qquad (22)$$

The optimal partial ownership $\hat{r}^*$ must satisfy the first-order condition

$$\frac{\partial \hat{\pi}_d}{\partial r \mid r = \hat{r}^*} = 0$$

We further have

$$(\partial \hat{a}^*/\partial r)[V'(\hat{a}^*) - C'(\hat{a}^*)] - \beta \hat{S}_T(r) - \beta\pi_0 \qquad (23)$$
$$-(1+\beta r)(1-a)(1-\lambda)V(\hat{a}^*)/(1-r)^2 = 0$$

Obviously, when $\beta > 0$ and is sufficiently small $\hat{r}^* \in (0, \lambda)$.Similar to the conclusions of last section, the value of $\hat{a}^*$ and $\hat{r}^*$ will be changed to correspond with positive or negative β-value. In this paper we will only analyze the case in which $\beta > 0$.

By Equation (23), we get

$$\frac{\partial^2 \hat{\pi}_d}{\partial r \partial \lambda} = [\partial \hat{a}^*/\partial r][V''(\hat{a}^*) - C'(\hat{a}^*)][\partial \hat{a}^*/\partial \lambda] - \frac{1+\beta r}{(1-r)^2} *$$
$$[-(1-\hat{a}^*)V(\hat{a}^*) - (1-\lambda)V(\hat{a}^*)(\partial \hat{a}^*/\partial \lambda) + (1-a)(1-\lambda)V(\hat{a}^*)(\partial \hat{a}^*/\partial \lambda)]$$
$$+[\partial^2 \hat{a}^*/\partial r \partial \lambda][V'(\hat{a}^*) - C'(\hat{a}^*)] + \frac{\beta(1-\hat{a}^*)V(\hat{a}^*)}{1-r} \qquad (24)$$

By $\frac{\partial \hat{S}_T(r)}{\partial a \mid a = \hat{a}^*} = 0$, we know

$$\partial \hat{a}^*/\partial r < 0,\ \partial \hat{a}^*/\partial \lambda > 0 \text{ □ } \partial^2 \hat{a}^*/\partial r \partial \lambda < 0\ .$$

Then, in Equation(24), all the right-hand terms exceed zero, thus

$$\frac{\partial^2 \pi_d}{\partial r \partial \lambda} > 0$$

Since $Sign(\partial r^*/\partial \lambda) = Sign(\partial^2 \hat{\pi}_d/\partial r \partial \lambda)$, we can get

$$\frac{\partial \hat{r}^*}{\partial \lambda} > 0$$

Similarly, $\frac{\partial \hat{r}^*}{\partial \pi_0} < 0$

From above analyses, we can conclude:

PROPOSITION 5: Assuming the upstream firm is a public-firm managed by the manager in the interest of the share-holders, when purchasing at premium price, the optimal equity participation ratio $\hat{r}^*$ by the downstream firm in the upstream firm increases in λ, but decreases in π_0.

5. Discussions: Optimal Partial Ownership and the Specific Investment Efficiency

The theory of optimal ownership structure extracts the distillate of two stream academic ideas: the financial structure theory and the managerial motivation theory, which have been agreed on in economic literatures(Dasgupta and Tao,2000) . For example, Jensen and Meckling(1976) pointed out, that agent costs caused by dilution of ownership are derived from the fact that the incentive of inside controllers can't keep track with that of the owner's. In another aspect, many academic papers demonstrate that an

outside artificial person who holds a major part of ownership has a positive effect on the firm's value(Williamson, 1983; Bolton and Whinston, 1993;Aghion and Bohton,1992). These papers emphasized the supervising function of the outside artificial persons' share-holders to the firm's managers. Compared with these existing articles, we provide a theoretical interpretation why outside artificial persons hold partial ownership under the circumstance of vertical buyer-seller relationship. Our result is that the downstream firm holds partial ownership of the upstream firm functions as a bonding mechanism, which improves the performance of two parties. It means that, compared with r=0, partial ownership mechanism arrangement improves the efficiency of the investor's specific investment.

However, can the optimal partial ownership result in social optimal specific investment level? Which is our focus of this section?

As we know, no matter what type the upstream firm is, either owner-managed one or a public-firm managed by managers, $r^* = \lambda$ or $r^* > \frac{1}{2}$ is the necessary condition bringing in social optimal investment type. If the upstream firm is an owner-managed one, it is only when the purchasing of partial ownership at par price occurs that choosing $r^* = \lambda$ is a rational decision for the downstream firm aiming at maximizing its net total income. But purchasing at premium price is dominant in reality, if calculated under general case of $\lambda = \frac{1}{2}$, the optimal partial ownership $r^* < \lambda$ is not large enough to motivate the decision-maker of the upstream firm to choose the most efficient invest specific degree. The marginal return obtained by the downstream firm through enlarging equity participation ratio will be offset by marginal costs of purchasing the equity ownership, premium price distorting effects lead to the efficiency loss of the upstream firm's investment $(r^* < \frac{1}{2})$. On the opposite, when purchasing at discount, over-motivation leads to $r^* > \lambda$, the investment efficiency loss may still occur. Therefore, we persist that, the wealth transfer effect of the equity ownership purchase is the main reason that lead to efficiency loss of the specific investment, which makes our theory about partial ownership different from the entrepreneur endeavor choice interpretation of Dasgupta and Tao's, but similar to the conclusion of Aghion and Tirole's that partial ownership arrangement can motivate investment, but can't solve the investors' under-investment problem totally.

However, when the upstream firm is public-managed, even if there exist $\beta = 0$ and the optimal partial ownership $\hat{r}^* < \lambda$, social optimal investment outcome can't still be obtained because the benefit of the downstream firm does not keep consistent with the trade parties' common benefit. When $\beta > 0$, $\hat{r}^*$ will become smaller, and the higher loss degree of the investment efficiency will occur. Obviously, under the second-order condition constraint to getting the optimal solution satisfying Equation(23), the larger average premium price parameter is the smaller $\hat{r}^*$ is, the lower invest efficiency becomes and the greater social welfare loss will be, which holds true in the case of owner-managed upstream firms. As for the case of $\beta < 0$, it accords with the aforementioned analyses, that is, the over-motivation of equity ownership may lead to investment efficiency loss.

When all technical parameters keep invariable, comparing optimal partial ownership in the cases of two different types of upstream firms, we can discover that, in theory, the ratio of optimal equity participation by the downstream firm in the owner-managed firm should exceed the ratio in the public-managed firm, that is, $r^* > \hat{r}^*$. It provides a theoretic foundation for us to interpret that the inter-firm mutual share-holding ratios of the member-firms within the familial firm group are much larger than that ratios within the public-firm groups. At the same time, it also means that the specific investment efficiency of the former is higher than the latter. Although there would be needs to be proved, we still persist that, the success of Japanese auto industry should mainly attribute to the owner-managed efficiency advantage.

Besides, No doubted, partial ownership mechanism arrangement improves the cooperative efficiency of two trade parties. Although the social welfare level this arrangement brings up is not optimal, the cooperative mechanism enhances the Pareto improvement of the return of two trade parties, compared with simple contract system.

6. Conclusions

The phenomena that one member-firm (a downstream firm generally) holds partial ownership of another firm (an upstream firm) within a firm group are often observed. Despite its importance, the existing interpretations for inter-firm partial ownership phenomena remain relatively unexplored. In this article, a theoretical explanation for inter-firm partial ownership arrangement existing between member-firms within firm groups is provided under the background of specific investment between vertical suppliers and buyers. Some important conclusions are obtained, including mainly:

(1) Based on the models in which we view the specific investment degree parameter as the selective variable of the upstream firm, we figure out, the simple contract (P_T, P_N) can not solve the low-efficient specific investment problem. Equity participation mechanism adding simple contract can improve the efficiency of specific investment. The partial ownership mechanism supported by specific investment plays a role as a bond in keeping the relational transactions among member-firms, but not a role as the efficiency-enhancing mechanism by

outside artificial persons' supervision in some articles about equity ownership structure.

(2) We install the average premium (discount) price parameter β into the models solving the optimal partial ownership, which interprets the difference of the partial ownership phenomena between Japanese and American firms well. Besides, on the base of keeping the logic deductive consistency, the outcome of the optimal partial ownership affected by the relative bargaining power λ of the downstream firm and the other outside income π_0 of the upstream firm, under two cases of owner-managed firm type and public-firm type respectively, are obtained.

(3) The correlations between the optimal partial ownership and specific investment efficiency are discussed, and it is pointed out that in the case of the owner-managed upstream firm, only when β=0, social optimal specific investment outcome is sure to be obtained, but when β>0(< 0), the result from the wealth transfer and distortion effect may be that the optimal partial ownership selected by the downstream firm is not large (small) enough to motivate (over-motivate) the entrepreneur to make the most efficient specific investment, which lead to the efficiency loss of investment. But in the case of public-firms, even if β=0, the social optimal investment outcome is difficult to be obtained. Compared with the case of the owner-managed upstream firm, when the technical parameters are the same, the efficiency loss in the case of upstream public-firm will be greater.

(4) Our theory provides a few cases in which we can verify the inter-firm equity participation ratio. Although many important conclusions we obtain seem to be consistent with some evidences, there is a need for in-depth researches.

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