내부자본시장에서의 경쟁이 사업다각화에 미치는 영향

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이 연구는 내부자본시장에서의 구조가 회사의 다각화에 어떠한 영향을 미치는지를 연구한다. 우리는 내부자산시장의 구조를 결정하는 요인 중에서, 희소한 내부 자원에대한 회사내 사업간의 경쟁, 사업간의 정보 관련성, 그리고 사업담당 매니저들의 절취가능성을 주목한다. 이 연구는 내부자본시장과 회사이론에 대해 새로운 명제들을 제시하게 된다. 다각화된 기업의 본부는 사업체 별로 분산되어있는 정보를 수집하고, 그 정보에 의거 우월한 프로젝트를 선택하게 된다. 본부의 이와 같은 두 가지 역할에 중요한 상충이 존재한다. 비관련 다각화가 상대적으로 유리한 경우는 사업체들이 자신의 프로젝트에 대해 정확한 정보를 보유하거나, 내부자본시장의 규모가 작아지거나, 사업체들이 수익성이 떨어지거나, 경기가 악화되거나, 사업체들이 보유자원에 대한 절취가 어려워질 경우 이다. 한편 집중화된 다각화가 유리할수록, 내부자본시장에서의 사회주의적 경향은 심화된다.

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How does the competition in internal capital market determine the optimal boundary of a firm?

We characterize internal capital market when divisions compete over internal resources, when the types of divisions are correlated, and when the divisions can divert outputs. The correlation measures the degree of diversification to indicate how much divisions are related. Thus, this paper generates theories about diversification as well as internal capital market. The headquarters collects information first, and then implements winner picking. In those two roles of headquarters exists the main economic tradeoff of this paper. We find that focus is more efficient organizational form than diversification, as divisions receive coarser signal about their future outputs, the size of internal capital market is larger, projects becomes more lucrative, economy becomes better and divisions divert output more easily. The higher the attractiveness of focus is, the higher the extent of socialism in internal capital market. Yet, the focus itself tends to weaken the socialism.

Key words: focus, diversification, internal capital market, winner picking, socialism

JEL classification: G31

This paper studies the internal capital allocation problem when the types of divisions are related and the divisions can divert outputs. We present a diversification theory in relation. It has widely believed that unrelated diversification is less prudent than related diversification (refer to Martin and Sayrak (2003) for related literature). Recent findings suggest mixed interpretations (Villalonga, 2004ab).

Diversification and internal capital market literature overlaps about the analysis of investment in related projects. Diversification is an investment decision. Suppose we control the valuation of projects including synergies between business lines. If managers tend to reduce shareholder values through unrelated diversification compared with related diversification, the managers for unrelated diversification invest capital inefficiently. This can mean that the internal capital market (ICM) of unrelated diversification can be inferior to that of related diversification since internal capital is very important source of investing (Myers and Majluf 1984). If capital market is perfect, then the capital budgeting is always optimal and based upon the attractiveness of individual projects. Then, neither related nor unrelated diversification matter. Because capital market is imperfect, internal capital market is created in order for the headquarters to allocate limited resources to projects as an intermediary. Thus, it is possible that the value difference between the two modes of diversification comes from the difference of the efficiencies of internal capital market. If we control valuation of projects, the value difference only comes from allocation of capital, which defines the efficiency of ICM. Then, our natural question is: when and why is the internal capital market of (unrelated) diversification less or more efficient than that of focus (related diversification)?

The answer is not obvious. Moreover, no previous researches provide clear insight. To refer to Stein (1997)'s winner picking story, unrelated diversification should be better. In the related diversification, the projects are more likely to succeed or fail together. The winner picking becomes irrelevant in those cases because there is neither winner nor loser for headquarters to select. Then internal resources are more likely to be idle than to be

invested in any productive project. Thus, focus should be less efficient if we believe Stein's story. Stein introduced judgment error to explain why focus can be better than diversification. However, can the judgment error story adequately explain why the capital budgeting of unrelated diversification is worse? If the headquarters is intelligent enough, does it mean that unrelated diversification should always dominate focus? Stein's story is not entirely satisfactory.

We use the correlation between divisions as a measure of diversification. Thus, when the correlation is highly positive, we define it 'related diversification' or 'focus'. On the other hand, when the correlation is low, we call it 'unrelated diversification' or simply 'diversification'. We use these definitions to relate optimal diversification with optimal internal capital market. Table 1 explains our concepts and definitions.

******* Table 1 *******

In our model, the headquarters functions in a specific manner. It first designs mechanism, collects information from various sources, and then processes the information. Next, it picks winner divisions in order to relocate resources toward it. It last compensates divisions. To summarize, the headquarters performs two important tasks: information processing and winner picking (check Table 1). Our insight is that correlation is good in information processing, but bad in winner picking stage. This presents the significant economic tradeoff in our model.

If winner picking becomes more important, firms tend to conduct diversification in order to reduce correlation. Diversification causes winner picking more relevant. In other case, focus is better because the headquarters can analyze the divisions better. The next expected question is when winner picking becomes more important than information processing. We find that information processing matters further as divisions

receive coarser signal about their future outputs, the size of internal capital market is larger, projects becomes more lucrative and divisions are more restraint to steal output. As a byproduct of our model, we can also explain the socialism existent in internal capital market (Scharfstein, 1998). Socialism is an empirical anomaly that good and bad division receive similar amount of internal resources, resulting in insensitivity of capital budgeting in response to the change of investment opportunities.

INNOVATIONS

Our model offers several innovations in diverse areas such as corporate finance, corporate strategy, internal-capital market and mechanism design. Firstly, we explain when focus can be better than diversification. The intuition of Cremer and McLean (1985, 1988) is useful. Cremer and McLean imply that the close relation between divisions can actually enhance internal capital market. We illuminate the link between the efficiency results of Cremer and McLean and the efficiency of internal capital market.

Secondly, we delve this correlation issue further to identify optimal diversification in view of internal capital market. Optimal diversification should be subject to the two balancing intuitions: Cremer and McLean vs. Stein. Clearly, the intuitions of Cremer and McLean and that of Stein conflict because the former supports focus (related diversification), but the latter backs diversification (unrelated diversification). Thus, the tradeoff between them should generate optimal solutions. This clarifies the connection between optimal diversification and efficient internal capital market. As far as we know, this paper is the first to identify the tradeoff in internal capital market and diversification in relation to the correlated mechanism design.

Thirdly, this paper has theoretical contributions in mechanism design. One nonstandard feature of our model is the gradual revelation of information. An agent reveals his type first, and later he reports output. The principal cannot observe both type and output. In addition, the signals

of the agents are correlated each other. This is an issue applicable to corporate finance, auction design, contract design and accounting. However, no study exists for this problem.

Fourthly, this paper extends Mezzeti (2004)'s two-stage revelation mechanism by examining not only serial correlation between type and output, but also cross-sectional correlation between types of agents. We also introduce competition between agents. We similarly extend DeMarzo and Fishman (2004)'s hidden cash flow problem to incorporate cross-sectional/serial correlations and multiple agents.

RELATED LITERATURE

Our paper is related with the literature about diversification, internal capital allocation/capital budgeting, mechanism design under correlation, and privately observed cash flow. Firstly, our paper is about diversification and internal capital market. Indeed, large amount of research papers are present about corporate diversification. Martin and Sayrak (2003) provide a survey on this topic. Several internal capital market papers are related with this paper also. We apply the winner picking idea of Stein (1997). Harris, Kriebel and Raviv (1982) and Antle and Eppen (1985) are the first papers to apply mechanism design approach to capital budgeting. They model the information asymmetry between the headquarters and divisions to analyze the role of transfer pricing. Harris and Raviv (1996) introduce auditing instead of transfer pricing. They show that it is optimal to set initial spending limits and to provide additional capital with the request from managers. Bernardo, Cai and Luo (2003) generalizes Harris and Raviv to two division case.

Secondly, we apply the mechanism design framework under correlation in order to investigate the internal capital allocation problem in the presence of correlated divisions. When the types of agents are correlated, it is shown that the principal can implement the same allocation as if she has full information about the types. It is well

investigated in Cremer and McLean (1985, 1988), McAfee, McMillan and Reny (1989), McAfee and Reny (1992). We additionally assume limited liability for the divisions. Demougin and Garvie (1991) show that the principal cannot implement the first-best solution and the agents earn rents from private information in case limited liability constraints bind. Our model also shows that the headquarters cannot extract full information rents from divisions, and the optimal solutions are not first best. Mezzetti (2004) studies two-stage mechanism as our paper does in which the agents observes signal at the first stage and their utility at the second stage. He finds that two-stage Vickrey-Clark-Groves mechanism can achieve an efficient perfect Bayesian allocation when standard mechanism cannot. Our model assumes that it is possible for agents to steal output. In addition, we impose limited liability constraints. Thus, in general, the efficient allocation is not achievable in our model.

Thirdly, another important feature of our model is that the division can divert cash flows. DeMarzo and Fishman (2004) characterize dynamic financial contracting when an agent can divert funds to himself. They showed that principle could implement the optimal contract with a collection of equity, long-term debt and a line of credit. Similar to their results, our model implies that the optimal contract between the headquarters and the divisions exhibits equity feature. Tchistyi (2005) extends the DeMarzo and Fishman's model to the case in which the cash flows are serially correlated. He finds that credit line interest rates increase with the balance on the credit line. Our model extends DeMarzo and Fishman by introducing private signals for future cash flows and multiple agents. The remainder of this paper is organized as follows. First, we explain the basic features of our model. Second, we present solutions and main results. Third, we study extensions. Final section proposes conclusion and future works.

SETTING

Three players, a headquarters and two managers in each division, exist in the game. Table 2 details our assumptions.

******* Table 2 *******

The structure of correlation makes our model distinct. The type and the output exhibits serial correlation, and the types of each division display cross-sectional correlation. Let us denote $\{s_i, v_i\}$ as true type and output of division i. We specify the serial and cross-sectional correlations as follows.

$$q_s \equiv Pr(s_1=s_2) \geq 1/2, \;\; q_d \equiv Pr(s_1 \neq s_2) \leq 1/2, \;\; q_s+q_d=1 \qquad (1)$$

$$p_s \equiv Pr(s_i=v_i) \geq 1/2, \;\; p_d \equiv Pr(s_i \neq v_i) \leq 1/2, \;\; p_s+p_d=1. \qquad (2)$$

In sum, $\{q_s, q_d\}$ characterizes cross-sectional correlations in a manner that q_s and q_d respectively quantify positive and negative association between divisions. Similarly, $\{p_s, p_d\}$ measures positive and negative serial correlation between type and output. We assume $p_s \in [1/2\ 1]$ without loss of generality. We also restrict our attention to $q_s \in [1/2\ 1]$. Negative correlation between divisions in a same firm ($q_d>1/2$) is trivial extension, but less realistic. Figure 1 summarizes such information structure in the internal capital market.

******* Figure 1 *******

The managers can announce the values {s,v} as {s´,v´}. We will call s´ type announcement and v´ as output report. We restrict the message space to the true space and impose truth-telling conditions, for the appropriate equilibrium concept of our model

is Bayesian Nash equilibrium. An incentive-compatible direct mechanism can represent any Bayesian Nash equilibrium of any Bayesian game. The headquarters' ability to commit to an allocation arises in various situations. Our model represents probably a repeated game between the headquarters and divisions. Then, by the Folk theorem, we can achieve any feasible and individually rational payoffs if both the headquarters and divisions are sufficiently patient. It is also certain that the optimal static allocation remains optimal in a dynamic context with commitment. Alternatively, our model is a characterization of utilities that equilibriums of noncooperative bargaining games can achieve between the headquarters and the divisions. If the two sides have identical time preference, such barging produces Bayesian equilibrium such that a mechanism exists and produces the same allocation (Fudenberg and Tirole 1996). Most realistically, we can assume that the headquarters commits to outsider investors about organization structure that specifies internal capital allocation rule. In this case, the headquarters can change the allocation rule only with the approval from board meeting. However, such change is not desirable to all participants of this game. The sequence of events is characterized in Table 3. We will explain the divisions' problem first and then present the headquarters' optimization problem.

******* Table 3 *******

DIVISIONS' PROBLEM

Divisions want to receive as much capital and compensation as possible. Divisions make two decisions. They decide whether to signal their type truthfully or falsely and then choose the amount of cash diversion. We restrict our attention to truth telling equilibrium without loss of generality. It means that the headquarters imposes incentive compatibility conditions so that the divisions announce their type truthfully and

report their output candidly. We also need participation constraints to satisfy the individual rationality of the divisions. We will assume that the compensation to divisions is nonnegative to ensure the condition. Upon the backward induction argument, we present the truthful output reporting conditions first and the truthful type announcing conditions next.

Truthful output reporting condition

Since we consider only truth telling Nash equilibrium, the pay offs are conditional on the truth telling by the other divisions. In addition, we do not have to consider the case when the actual output is low. When the actual output is zero, a division has no cash flow to steal. Thus, the division with low output always reports truthfully. Only the division with high output ever lies about its output. Although it is a conjecture, it can be easily proven true. In the similar vein, the high output reporting is always true, but low output reporting can be a lie. It is also easy to prove: since a low output division never lies, the high output report should be true. Following notations are useful. Let us ignore subscript for divisions due to the symmetry of them.

- w(0HHH): The first two arguments {0H} are the low type announcement (0) and the high output report (H) by a reference division. The latter two arguments {HH} show the high type announcement and high output report of the other division. The compensation is the function of the reference division's signal {0H} and the other division's signal {HH}. w(0000), w(000H), …, w(HHHH) are defined in the same way.
- a(H0): The internal capital allocation is a function of the type announcements of divisions. The first (H) is from the reference division and the second (0) from the other division.

Let us consider the reference division's truthful output reporting condition. When the reference division produces 0, it tells truth. When the reference division produces H, it reports output truthfully only when truthful output reporting offers higher pay off. Suppose the other division's {type, output} is {A,B}, then

Payoff from truthful output reporting: $w(s'HAB)$ (3)

Payoff from dishonest output reporting: $w(s'0AB)+\lambda a(s'A)H$ (4)

Truthful output reporting condition:

$$w(s'HAB) \geq w(s'0AB)+\lambda a(s'A)H. \quad (5)$$

The reference division will receive $w(s'HAB)$ given its type announcement s' and the other division's signal {A,B} under truthful reporting. If it lies, it will receive $w(s'0AB)$ and will divert $a(s'A)H$ to report zero output. $(1-\lambda)$ is diverting discount (DeMarzo and Fishman, 2004), so the division can keep only λ fraction of total embezzlement. Thus, its pay off from dishonest output reporting becomes $w(s'0AB) + \lambda a(s'A)H$. Because the headquarters will not compensate the divisions more than necessary, the incentive-compatible optimal compensation should satisfy:

$$w(s'HAB) = w(s'0AB)+\lambda a(s'A)H. \quad (6)$$

Truthful type announcing condition

Suppose truthful output reporting condition is in place. In this case, what is the truthful type announcing condition? Consider the other division's {type, output}={A,B} is given. Let us denote s and s' are truthful and dishonest type announcing respectively. Then,

Payoff from truthful type announcing: $E(w(s\tilde{v}AB)|s,A,B)$ (7)

Payoff from dishonest type announcing: $E(w(s'\tilde{v}AB)|s,A,B)$ (8)

The future output $\tilde{v}$ is random variable such that $Pr(s=\tilde{v})=p_s$ and $Pr(s\neq\tilde{v})=p_d$. Also, $Pr(A=B)=p_s$ and $Pr(A\neq B)=p_d$ hold from our assumption. Since the reference-division cannot observe the signal of the other division {A, B}, the truthful type announcing condition becomes

$$E\{E(w(s\tilde{v}AB)|s,A,B)|s\} \geq E\{E(w(s'\tilde{v}AB)|s,A,B)|s\}. \quad (9)$$

The other division's type (A) is random variable such that $Pr(s=A)=q_s$ and $Pr(s\neq A)=q_d$. To summarize, the incentive compatible optimal compensation should satisfy:

$$w(s'HAB) = w(s'0AB)+\lambda a(s'A)H \text{ for all A and B} \quad (10)$$

$$E\{E(w(s\tilde{v}AB)|s,A,B)|s\} \geq E\{E(w(s'\tilde{v}AB)|s,A,B)|s\} \text{ for all } s'. \quad (11)$$

We have inequality in the truthful type announcing condition due to the information rents that may be present.

HEADQUARTERS' PROBLEM

The goal of HQ is to maximize profit. The symmetry between two divisions can simplify the headquarters' problem. Suppose {A, B} and {C, D} are the signals from the reference division and the other division respectively. (A, C) are type signals. (C, D) are

output signals. Given the signals {{A,B},{C,D}}, the profit of the headquarters is defined as,

$$r(ABCD) \equiv (B\ a(AC)-w(ABCD))+(D\ a(CA)-w(CDAB))+r_f(2-a(AC)-a(CA)). \quad (12)$$

r_f is risk free rate, and we will normalize it to one without loss of generality. (B*a(AC)-w(ABCD)) is the revenue from the reference division, and (D*a(CA)-w(CDAB)) is from the other division. To remind, B and D are either H or 0. So, if a is invested, the output becomes either H*a or 0*a. Since a(AC)+a(CA) is invested, the revenue from the risk free asset is r_f(2-a(AC)-a(CA)). Since the headquarters cannot observe {A, B, C, D} directly, it has to integrate them out. Thus, the headquarters' optimization problem is:

Max: E[r(ABCD)] with respect to a(•) and w(•) (13)

Subject to:

- Truthful type announcing condition
- Truthful output reporting condition
- Limited liability condition $w(\bullet) \geq 0$
- Resource constraint: $\Sigma\ a(\bullet) \leq 2$ and $a(\bullet) \geq 0$.

We can regard truthful type announcing and output reporting conditions as incentive compatibility conditions. Similarly, limited liability condition replaces participation condition.

It is possible that there exist a reputation cost c(ABCD) which is a function of the signals {{A,B},{C,D}}. For instance, c(H0CD), which specifies the reputation effect when the type announcement is high, but output report is low, denotes the reputation cost

of being stealer given the other division's signal is {CD}. Similarly, c(0HCD) can be interpreted as the reputation cost of being incompetent given the other division's signal is {CD}. In case we introduce reputation cost, both truthful type announcing and truthful output reporting conditions change accordingly.

SOLUTIONS (WITHOUT REPUTATION COST)

Suppose reputation cost is always zero. Then we have following results.

Lemma 1*: w(A0CD)=0 and w(AHCD)=λHa(AC) for all A, C and D.*

Since the proofs are straightforward, we will explain intuitions only. Suppose the headquarters increases w(A0CD) > 0, then it implicitly subsidizes dishonest reporting by high type. To induce truthful output reporting, the headquarters should increase w(AHCD) too. This is clearly suboptimal. Thus, w(A0CD) should be zero for all A,C and D in order to penalize low output reporting as much as possible. Next, suppose we have w(AHCD) < λHa(AC). Then, the reference division will divert the output Ha(AC) and claim it could not produce anything. Then, the division can keep λHa(AC) instead of w(AHCD). Thus, we should have w(AHCD) ≥ λHa(AC) to induce truthful output reporting. Therefore, w(AHCD) = λHa(AC). We can interpret the contract as equity. λ is a profit-sharing parameter.

The condition w(A0CD)=0 and w(AHCD)=λHa(AC) make sure truthful output reporting. Then, what will be truthful type announcing conditions? Let us define following convenient notations

$$x_1 \equiv a(HH)-a(0H) \quad (14)$$

$$x_2 \equiv a(H0)-a(00). \quad (15)$$

Clearly, the headquarters wants to increase x_1 and x_2. In other words, the headquarters tries to take internal resources away from less attractive divisions and invests in better divisions. This is typical winner picking argument. Alternatively, we can interpret x_1 and x_2 as the sensitivity of capital budgeting in response to the change of investment opportunity conditional on the other division's type. If we integrate out the other division's type, we will get the sensitivity of internal capital allocation in response to investment opportunity. We define x_3 as follows to mark the unconditional sensitivity.

$$x_3 \equiv a(H\bullet)-a(0\bullet) = (q_s\, a(HH) + q_d\, a(0H)) - (q_d\, a(H0) + q_s\, a(00)). \qquad (16)$$

Empirical researches have found that those sensitivities (x_1, x_2 and x_3) are not large enough. In other words, the headquarters tends to over-invest in weak line of business, and under-invests in strong business. In addition, the capital budgeting does not respond well when a division's investment opportunity changes. Internal capital market literature calls this phenomenon as 'socialism' (Scharfstein, 1998). In our model, the truthful type announcing conditions explains such empirical anomaly. We can simplify the truthful type announcing conditions for high and low type divisions as follows.

$$\text{High type: } q_s\, x_1+q_d\, x_2 \geq 0 \qquad (17)$$

$$\text{Low type: } -q_s\, x_2-q_d\, x_1 \geq 0. \qquad (18)$$

If high type division lies, it can increase the capital budgeting by $a(0H)-a(HH)=-x_1$ when the other division is high type and by $a(00)-a(H0)=-x_2$ when the other division is low type. Each case occurs with probability q_s and q_d respectively. Hence, $q_s x_1+q_d x_2$ is the marginal increase in capital budgeting with truth telling. Thus, the truthful type

announcing condition of high type division states that the division should not receive more internal capital with dishonest type announcing. Similarly, we derive the truthful type announcing condition for low type. To arrange the incentive compatibility conditions, we have

$$-(q_d/q_s)\, x_2 \leq x_1 \leq -(q_s/q_d)\, x_2. \quad (19)$$

For above inequalities to be meaningful, we need following condition.

$$q_s > q_d \text{ then } x_2 < 0 \text{ or } q_s < q_d \text{ then } x_2 > 0. \quad (20)$$

Since we consider only the case $q_s \geq q_d$, $x_2 \leq 0$ should hold, which means that the sensitivity of internal capital allocation in response to investment opportunity is negative. *This results in the socialism* in internal capital market such that headquarters subsidize low type projects at the expense of better one. In case $q_s < q_d$, then $x_1 < 0$ holds. Thus, the socialism occurs in any case through either x_1 or x_2.

The lower bound of x_1 is defined with high-type's truthful type announcing condition and the upper bound with low-type's truthful type announcing condition. Intuitively, the headquarters should maximize x_1 as much as possible. Thus, we have:

$$x_1 = -(q_s/q_d)x_2. \quad (21)$$

This in turn implies that low type's truthful type announcing condition binds, but the high type enjoys information rents. Following proposition summarizes the results until now.

Proposition 2*: Truthful type announcing condition induces socialism in internal capital market. Truthful output reporting condition results in equity/ profit-sharing contract between headquarters and divisions. High type division enjoys information rents.*

Let us characterize the internal capital allocation further. Suppose q_s is very high. Then, the optimal solution is clearly a(HH)=a(0H)=1 and a(H0)=(a00)=0 such that $x_1=x_2=0$. Then, the incentive compatibility conditions are trivially satisfied. It is inefficient to set a(0H)=1 > a(H0)=0. a(H0) is internal capital allocation to high type division, so that a(H0) should be larger than a(0H). However, since q_s (correlation) is high, such events are rare.

No-arbitrage condition, one hidden assumption of ours, is that $(1-\lambda)\ H/2 \leq 1$. $(1-\lambda)$ H/2 is expected return per investment when the headquarters randomly decides investment without researching any project. Unconditionally, a division generates high output with probability 1/2. Given the equity-like contract between the headquarters and a division, the headquarters can expect $(1-\lambda)$ H/2 per investment. We presume such investment generates return less than risk free rate to prevent arbitrage.

Even when q_s (correlation) is not large, a(HH)=a(0H)=1 and a(H0)=(a00)=0 are still optimal solutions as far as $q_s>1/2$ (positive correlation). To remind, we restrict our attention to positive correlation. This allocation means that the headquarters invests in a division only when the other division is high type. Since the types of division exhibit positive correlation, such allocation makes sense. Indeed, the reference division is more likely to be high type when the other division is high type too. In addition, a division does not have incentive to manipulate its own type since the capital budgeting is determined by the other's type announcement. Table 4 presents the payoff to the headquarters in this case.

******* Table 4 *******

The revenue of the headquarters (r_{01}) is:

$$r_{01}=H(1-\lambda)(q_s p_s+q_d p_d)+1. \quad (22)$$

On the other hand, if the headquarters invests only in risk free asset, the revenue is $r_{01}=2$. Suppose the critical value q_s^* makes it indifferent whether to invest in risk free asset or risky projects.

$$H(1-\lambda)(q_s^* p_s+(1-q_s^*) p_d)+1=2. \quad (23)$$

Thus, we have the sub cases as Table 5 and express the firm value as a function of q_s as Figure 2.

******* Table 5 and Figure 2 *******

Unless q_s^* is greater than one, the firm value increases with q_s. Thus, the firm value is weakly increasing function of focus. Following claim summarizes the result.

Lemma 3*: With little reputation effect, focus is always better organization structure than diversification.*

We believe the result can be the first one to show why internal capital market in unrelated diversification firm can be inferior to that in related diversification firm although investment opportunities remain constant.

SOLUTION (WHEN REPUTATION CONCERN IS VERY HIGH)

Suppose divisions should bear large reputation cost when reported output is different from announced type. Then, the divisions will announce their types truthfully. In this case, the headquarters invest in high type to maximum and does not invest in low type. Table 6 characterizes the payoff to the headquarters.

******* Table 6 *******

In this case the profit of the headquarters (r_{02}) is:

$$r_{02}= H(1-\lambda)(q_s p_s + 2 q_d p_s) +1. \quad (24)$$

If the headquarters invests only in risk free asset, the revenue is $r_{02}=2$. The critical value of q_s^* solves $H(1-\lambda)(q_s+2q_d)p_s+1=2$. Thus, we have the sub cases as Table 7 and express the firm value as a function of q_s as Figure 3.

******* Table 7 and Figure 3 *******

Unless q_s^* is greater than one, the firm value is strictly decreasing function of q_s. Thus, the firm value is weakly decreasing function of focus if reputation effect is large enough to induce truth telling. One possible extension of this result is that when social capital is rich, diversification can perform better.

Proposition 4*: If reputation effect is very large, diversification is better organization structure than focus for multi-division firms.*

SOLUTION (INTERMEDIATE REPUTATION COST)

Next, what will happen if the reputation concern is moderate? We assumed that there exist exogenously given reputation function c(s,v,•,•) subject to the type (s) and output (v) of the subject division. Let us specify that reputation cost occur when type announcement and output report do not coincide as follows.

$$c(0HAB) = c(H0AB) = -c \quad \text{for all A and B.} \tag{25}$$

We can interpret c(0H••) as the reputation cost of being incompetent. c(H0••) is the reputation cost of being a stealer. Given the exogenous reputation considerations, we restate the truthful output reporting condition as the following lemma.

Lemma 5*: Truthful output reporting condition is w(A0CD)=0, w(0HCD)=λHa(0C)+c, w(HHCD)= λHa(HC)-c for all A, C and D.*

The proof is straightforward, and its intuition is similar to c=0 case. w(A0CD)=0 is obvious because the headquarters does not want to compensate dishonest output reporting and low outputs. Indeed, if w(•0••) is positive, a division has more incentive to report low output when its actual output is high. w(0HCD)=λHa(0C)+c needs some explanations. When a division announces low type, the headquarters should compensate reputation cost when the realized output of the low type is high. The division should bear the reputation cost of being incompetent by reporting output truthfully. Thus, it has more incentive to divert output in order to avoid the reputation cost. The headquarters can remove the division's reputation concern by providing additional compensation c in case of high output report. The intuition of equity contract λHa(0C) is same to the case c=0. w(HHCD)= λHa(HC)-c can be interpreted similarly. When a division announces high

type, it has less incentive to report output dishonestly. If it diverts output and reports low output, it has to bear reputation cost of being a liar. The headquarters sees through such incentive of the high type division. Therefore, it can take c away from the high type division when reported output is high.

Next, given the truthful output reporting conditions, what will be truthful type announcing conditions? The truthful type announcing conditions for high and low type divisions are as follows.

$$\underline{\text{High type}}: p_s \lambda H (q_s x_1 + q_d x_2) - c \geq 0 \quad (26)$$

$$\underline{\text{Low type}}: p_d \lambda H (-q_s x_2 - q_d x_1) + c \geq 0 \quad (27)$$

$$x_1 \equiv a(HH) - a(0H) \quad (28)$$

$$x_2 \equiv a(H0) - a(00). \quad (29)$$

The intuitions for the conditions are as follows.

<u>High type</u>: $q_s x_1 + q_d x_2$ is the expected marginal increase of internal capital when a high-type division announces its type truthfully rather than untruthfully. Provided the marginal increase of internal capital and equity contract between headquarters and divisions, $\lambda H(q_s x_1 + q_d x_2)$ is the expected marginal increase of pecuniary payoff with truthful type announcement. The high type division will lose reputation cost c whether it reports high output or not. When it reports high, the headquarters takes c away. If the output reporting is low, it will be regarded as a liar and lose reputation by c again. Thus, $p_s \lambda H(q_s x_1 + q_d x_2) - c$ denotes the relative benefit of announcing high type instead of low type. Such benefit should be nonnegative for the high type division to announce its type truthfully.

Low type: A low type division never bears reputation cost. If it reports high output, the headquarters provides the low type division with c to compensate the reputation cost of being incompetent. If it reports low, there is no reputation cost. Since a high type division always bears reputation cost c, the low type division enjoys relative marginal benefit c by announcing its type truthfully. In addition, $(-q_s x_2 - q_d x_1)$ is the expected marginal increase of internal capital when the low type division announces truthfully. Thus, $p_d \lambda H(-q_s x_2 - q_d x_1)$ is the expected marginal benefit of truthful type announcing from the equity contract. The headquarters should ensure the total marginal benefit $p_d \lambda H(-q_s x_2 - q_d x_1) + c$ nonnegative in order to ensure truthful type announcing by the low type division.

The truthful type announcing condition implies that the range of x_1 is,

$$-(q_d/q_s)\, x_2 + t_2/q_s \leq x_1 \leq -(q_s/q_d)\, x_2 + t_1/q_d \qquad (30)$$

in which

$$t_1 \equiv c/(p_d\, \lambda\, H) \qquad (31)$$

$$t_2 \equiv c/(p_s\, \lambda\, H). \qquad (32)$$

Thus, the lower bound of x_1 is defined with high-type's truthful type announcing condition, and the upper bound with low-type's condition. Intuitively, x_1 should be maximized. Thus, $x_1 = -(q_s/q_d)x_2 + t_1/q_d$ should hold. This in turn implies that low-type's incentive compatibility condition binds, and the high-type gains information rents.

Next, suppose the headquarters has 2B unit of internal capital. We consider the most intuitive solution of a(HH) = B and a(00) = 0. It is intuitive because the headquarters invests maximum internal resources when all divisions are high type, but

minimum when all divisions are low type. Then, we have following a simplified restriction to satisfy the truthful type announcing conditions for both high-type and low-type.

$$B\text{-}a(0H) = -(q_s/q_d)\, a(H0) + t_1/q_d. \quad (33)$$

In this situation, we can conjecture two corner solutions to notice the linearity of our optimization problem.

$$a(0H) = 0 \text{ and } a(H0) = (t_1/q_d\text{-}B)(q_d/q_s) \quad (34)$$

$$a(0H) = (B\text{-}\, t_1/q_d + 2Bq_s/q_d)/\, (1+q_s/q_d) \text{ and } a(H0) = (B + t_1/q_d)/(1+q_s/q_d). \quad (35)$$

The first case denotes the case that the headquarters invests as small as possible in low-type, when the other division is high-type. The second case shows maximum investments in a(H0).

If $(1\text{-}\lambda)(p_sq_d + p_dq_s)\, H \geq 1$, then the second one holds. Otherwise, the first one holds. $(p_sq_d+p_dq_s)$ is the conditional probability that a division produces high output given the other division is low type. Thus, $(1\text{-}\lambda)(p_sq_d+p_dq_s)H$ means conditional profit per investment given low-type of the other division. To prevent arbitrage, we have assumed that the headquarters will lose money if it disregards type announcing: $(1\text{-}\lambda)H/2\leq 1$. This implies that only the first one should hold ($(p_sq_d+p_dq_s) < 1/2$ if $q_s > 1/2$). Thus, $a(0H) = 0$ holds, and we have followings.

******* Table 8 *******

To take derivative the objective function with respect to q_s, the equation is proportional to

$((1-\lambda)p_s H-1)\ (p_d\ \lambda\ H-c/B)$. (36)

To solve the equation, we derive the threshold c to make diversification irrelevant: $c^* = Bp_d\lambda H$. Thus, when $c>c^*$, then diversification is better. Otherwise, focus is better. In addition, the increase of p_d, λ and H tends to make focus more attractive compared with diversification.

Proposition 6*: A threshold reputation cost exists to equalize the benefits of focus and diversification. If reputation cost is greater than the threshold, diversification dominates focus. Otherwise, focus becomes better*.

Proposition 7*: As divisions are better informed compared with the headquarters, diversification is better. On the other hand, the increase of project returns (H) and cash diversion efficiency (*λ*) makes focus better. The size of internal capital market (B) makes focus attractive too.*

One interpretation of the result is as follows: It is harder for the headquarters to implement winner picking if divisions have more incentive to dishonestly announce themselves as high type. Thus, when divisions have higher incentive for dishonest type announcing, focus becomes better organizational structure. Indeed, when λ, H and B are large, lower type divisions have more incentive to lie. Once a lower-type receives internal resource, it can receive a lot of it (high B), can collect further fraction of output (high λ), can generate higher return (high H) and more likely to generate high output (high p_d).

Next, we can find implication for the socialism in internal capital market. Winner picking hypothesis argues that a high-type division should receive more internal resources when the other division is low-type than high-type ($a(H0) > a(HH)$). Therefore,

the socialism in internal capital market happens when $(t_1/q_d\text{-}B)(q_d/q_s)$ is less than B. Hence, we can define the measure of socialism as $B\text{-}(t_1/q_d\text{-}B)(q_d/q_s)$. Then, we can derive following proposition.

> ***Proposition 8****: As divisions are better informed, the socialism decreases in internal capital market. On the other hand, the increase of project returns (H) and cash diversion efficiency (λ) make socialism more pronounced. Size of internal capital market (B) makes socialism more serious too. Focus tends to weaken socialism. Higher reputation cost declines the socialism.*

In sum, as focus becomes more attractive, the socialism in internal capital market becomes more obvious. Yet focus itself tends to weaken the socialism. Focus becomes better organizational design as divisions have more incentive to announce their type fraudulently. Socialism should be prevalent in that case. Indeed, it is costlier to distinguish higher and lower type divisions when such incentive is high. However, once the headquarters implements focus, the headquarters can identify the types of divisions more easily. Hence, the headquarters can decrease socialism.

CONCLUSION

We characterize internal capital allocation when the types of divisions show correlation, and when the divisions can divert outputs. The correlation measures the degree of diversification to indicate whether the divisions are related or unrelated. We find that focus is more efficient organizational form than diversification, as divisions receive coarser signal about their future outputs, the size of internal capital market is larger, projects becomes more lucrative, economy becomes better and divisions can divert output more easily. We can also explain socialism in internal capital market. As focus

becomes more attractive, the socialism in internal capital market becomes more obvious. Yet focus itself tends to weaken the socialism.

The main economic force behind our results is the tradeoff between the winner picking ability and the information processing ability of headquarters. The headquarters first collects information and then implements winner picking. In those two roles of headquarters exists the main economic tradeoff of this paper. Correlation makes the information processing easier, but renders winner picking less relevant.

This paper suggests many future research topics. We have ignored the presence of limited reversibility and expandability in internal capital market. In fact, the limited reversibility and expandability are important topics in real option and investment theory literature. Thus, it will generate further implication to combine internal capital market models with investment theories. The possibility of communication between divisions can do important role also. We assume that the divisions can neither collude nor communicate. We can relax this setup in order to allow divisions to talk each other. In addition, we can make divisions disclose signals sequentially instead of simultaneously. Then it will be an interesting research topic to study whether the orders of type announcing and output reporting matter. Furthermore, we can investigate how the internal communication affects the structure of internal capital market.

Another open question is the general results about the efficiency of mechanism when the information is gradually exposed. The two-stage mechanism design is the natural framework for this setting. Then, it is uncertain how the possibility of cash diversion and correlation among signals in general affects the mechanism under limited liability. We can also extend long term financial contracting and security design research further to incorporate situations that both signal and output are privately observed and the agents compete for funding.

We can find interesting empirical topics too. We can test the relationship between internal capital allocation and observability of signal and output. Key variables in our

model can explain part of the diversification premium/discount. As far as we are aware, there are no research papers about them despite the obvious potentials.

REFERENCE

Antle, R. & Eppen, G.D. 1985. ***Capital rationing and organizational slack in capital budgeting***. Management Science, 31 (2): 163 -- 174.

Bernardo, A.E. & Cai, H. & Luo, J. 2001. ***Capital budgeting and compensation with asymmetric information and moral hazard***. Journal of Financial Economics, 61 (3): 311 -- 344.

DeMarzo, P.M. & Fishman, M.J. 2007. ***Optimal long-term financial contracting***. Review of Financial Studies, 20 (6): 2079 -- 2128.

Demougin, D.M. & Garvie, D.A. 1991. ***Contractual design with correlated information under limited liability***. Rand Journal of Economics, 22 (4): 477 -- 489.

Fudenberg, D. & Tirole, J. 1991. ***Game Theory***. Boston: MIT Press.

Harris, M. & Kriebel, C.H. & Raviv, A. 1982. ***Asymmetric information, incentives and intrafirm resouce allocation***. Management Science, 28 (6): 604 -- 620.

Harris, M. & Raviv, A. 1996. ***The capital budgeting process: incentives and information***. Journal of Finance, 51 (4): 1139 -- 1174.

Martin, J.D. & Sayrak, A. 2003. ***Corporate diversification and shareholder value: a survey of recent literature***. Journal of Corporate Finance, 9 (1): 37 -- 57.

McAfee, R.P. & McMillan, J. & Reny, P.J. 1989. ***Extracting the surplus in the common value auction***. Econometrica, 57 (6): 1451 -- 1459.

McAfee, R.P. & Reny, P.J. 1992. ***Correlated information and mechanism design***. Econometrica, 60 (2): 395 -- 421.

Mezzetti, C. 2004. ***Mechanism design with interdependent valuation: efficiency***. Econometrica, 72 (5): 1617 -- 1626.

Myers, S.C. & Majluf, N. 1984, ***Corporate Financing and Investment Decisions When Firms Have Information that Investors Do Not Have***, Journal of Financial Economics , 13 (2): 187-221.

Scharfstein, D.S. 1998. ***The dark side of internal capital markets II: evidence from diversified conglomerates***. NBER working paper, W6352.

Tchistyi, A. 2005. ***Security design with correlated hidden cash flows: the optimality of performance pricing***. Working Paper, Haas School of Business.

Villalonga, B. 2004. ***Does diversification cause the 'diversification discount'?***. Financial Management, 33 (2): 5 -- 27.

Villalonga, B. 2004. ***Diversification discount or premium? New evidence from the business information tracking series***. Journal of Finance, 59 (2): 479 -- 506.

Table 1

Concepts and definitions

Concepts	Nominal definition	Operational definition
Focus	Focus denotes related diversification. It occurs when the operation of projects in a firm is highly related.	The probability of success and fail of a project is close to 1 when the other project succeeds and fails respectively.
(unrelated) Diversification	For simplicity, we call unrelated diversification as diversification. (Unrelated) diversification occurs when the operation of projects in a firm is close to independence.	The probability of success and fail of a project is close to 1/2 when the other project succeeds and fails respectively.
Information processing	HQ (headquarters) collects information from various sources and integrates it to identify the types of divisions	HQ estimates the type of a project based on the signal from the other.
Winner picking	HQ provides internal resources more to good divisions, but less to bad divisions	HQ reallocates internal resources to better projects based on the estimates of projects.

Table 2
Assumptions

Concepts	Operationalization	Setting
Divisions	A division has one manager and one investment opportunity.	Two divisions exist in our model
Managers	A manager takes charge of a division and conduct projects	Managers maximize their own cash flows and reputation. Managers can steal and lie about cash and investment opportunities.
Headquarters	A headquarters (HQ) exists and owns property rights over cash flows and assets of divisions.	HQ owns two units of internal capital. HQ maximizes firm value.
Technology	The technology in our model produces outputs at second period and the information about the outputs ('type') at first period.	Each division produces either H (high) or 0 (low) returns per investment with probability 1/2 unconditionally. In addition, it receives signal about the output (type) either H or 0 with probability 1/2 unconditionally.
Types	The divisions can observe signals (types) that predict future cash flow at first period, and then observe cash flow at second period.	The output and signal are same with probability p_s, but different with probability p_d. $p_s+p_d=1$. The signals of two divisions are same with probability q_s, but different with probabilty q_d. $Q_s+q_d=1$.
Information asymmetry	The managers in divisions can observe information about their type and output at first and second period respectively. However, HQ cannot.	The divisions announce its type at first period to receive internal capital and output at second period to receive compensation. The headquarters cannot observe the true information about either signal or output.

Table 3

Sequence of events

Seq	Event	Explanation
1	Contracting	In the beginning, the headquarters announces a contract (mechanism) that stipulates the rule to allocate internal capital and to compensate divisions as a function of the history of type announcement and output report.
2	Private signal on types	Divisions receive the private signal about their types that the headquarters cannot observe. The division with high signal (s=H) is referred as high type henceforth. Low type division refers the division with the low signal (s=0).
3	Type announcement	Divisions make strategic decision whether to announce their types truthfully or falsely.
4	Internal capital allocation	The headquarters allocates internal capital based on the announcement of divisions.
5	Output realization	The divisions observe cash flows that the headquarters cannot.
6	Cash diversion and output report	The divisions determine whether to divert outputs or to report them truthfully to the headquarters.
7	Compensation	The headquarters compensates the divisions based on the history of type announcements and output reports.

Table 4

Profit of headquarters from each investment opportunity (Without reputation cost)

	Prob	Division 1	Division 2	Riskfree inv.
{HH}	$q_s/2$	p_s H (1-λ)	p_s H (1-λ)	0
{H0}	$q_d/2$	0	p_d H (1-λ)	1
{0H}	$q_d/2$	p_d H (1-λ)	0	1
{00}	$q_s/2$	0	0	2

The first column is the set of type announcements from divisions. The probability for the type announcements are at the second column. The third, fourth and fifth column are the revenue from each division and risk free asset.

Table 5

Internal capital allocation (Without reputation cost)

Situation	Allocation
$q_s^* \geq 1$	The headquarters always invests only in risk free asset
$q_s^* < 1/2$	The headquarters invests one unit to the reference division when the other division is high type. Otherwise it invests only in risk free asset
Otherwise	When $q_s > q_s^*$, the headquarters invest as if $q_s^* < 1/2$. When $q_s < q_s^*$, it invests as if $q_s^* \geq 1$.

The optimal internal capital allocation is subject to the focus of firm (q_s).

Table 6
Profit of headquarters from each investment opportunity (With large reputation cost)

	Prob	Division 1	Division 2	Risk free inv.
{HH}	$q_s/2$	p_s H (1-λ)	p_s H (1-λ)	0
{H0}	$q_d/2$	2 p_s H (1-λ)	0	1
{0H}	$q_d/2$	0	2 p_s H (1-λ)	1
{00}	$q_s/2$	0	0	2

The first column is the set of type announcements from divisions. The probability for the type announcements are at the second column. The third, fourth and fifth column are the revenue from each division and risk free asset.

Table 7

Internal capital allocation (With large reputation cost)

Situation	Headquarters behavior
$q_s^* \geq 1$	The headquarters invests in high type, but does not in low type
$q_s^* < 1/2$	The headquarters invests only in risk free asset
Otherwise	When $q_s > q_s^*$, the headquarters invest as if $q_s^* \geq 1$. When $q_s < q_s^*$, it invests as if $q_s^* < 1/2$.

The optimal internal capital allocation is subject to the focus of firm (q_s).

Table 8

Profit of headquarters from each investment opportunity (With moderate reputation cost)

	Prob	Division 1	Division 2	Riskfree inv.
{HH}	$q_s/2$	$p_sH(1-\lambda)$ B	p_s H $(1-\lambda)$ B	0
{H0}	$q_d/2$	$p_sH(1-\lambda)$ $(t_1/q_d-B)(q_d/q_s)$	0	$2B-(t_1/q_d-B)(q_d/q_s)$
{0H}	$q_d/2$	0	p_s H $(1-\lambda)$ $(t_1/q_d-B)(q_d/q_s)$	$2B-(t_1/q_d-1)(q_d/q_s)$
{00}	$q_s/2$	0	0	2B

The first column is the set of type announcements from divisions. The probability for the type announcements are at the second column. The third, fourth and fifth column are the revenue from each division and risk free asset.

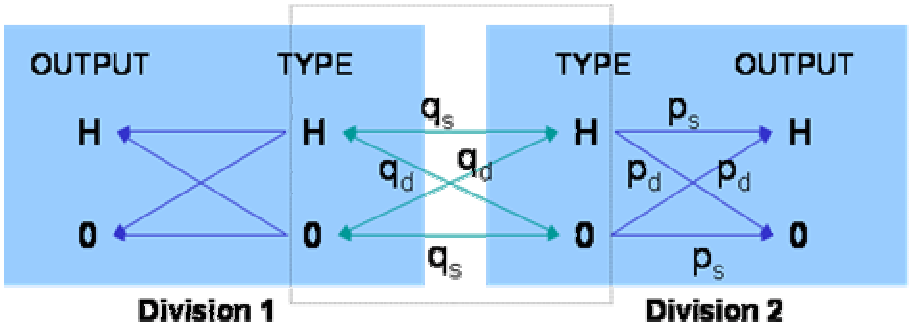

Figure 1
Information structure of internal capital market

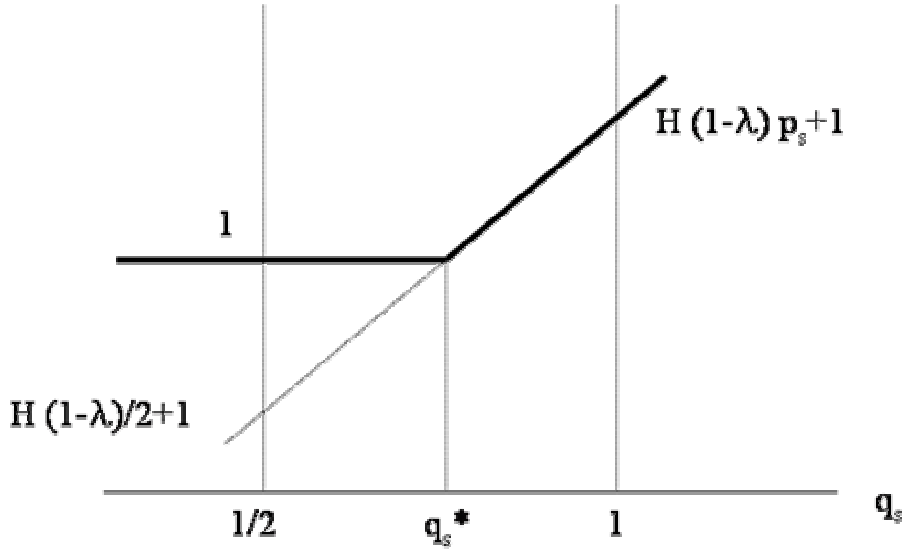

Figure 2
Firm value (without reputation cost)

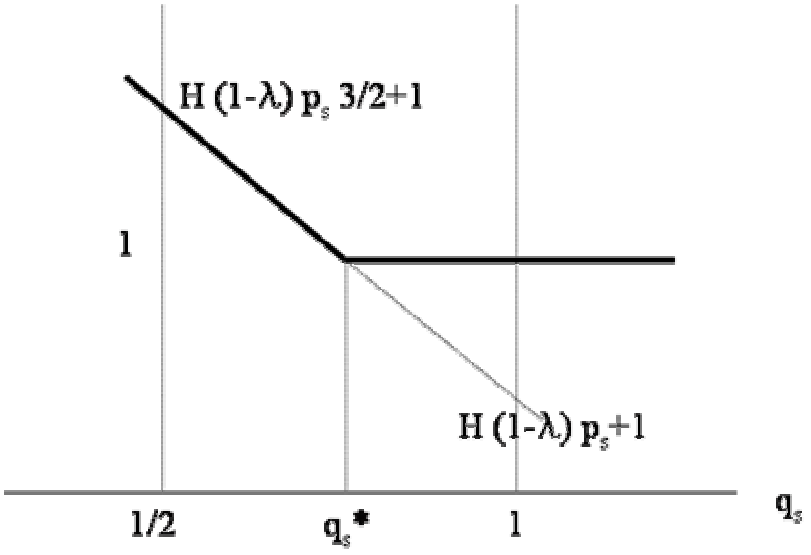

Figure 3
Firm value (with large reputation cost)