Diversification Discount, Information Rents, and Internal Capital Markets

Chongwoo Choe*
Australian Graduate School of Management
University of New South Wales
Sydney, NSW 2052, Australia
c.choe@agsm.edu.au

and

Xiangkang Yin
Department of Economics and Finance
La Trobe University
Melbourne, Vic 3083, Australia
x.yin@latrobe.edu.au

ABSTRACT

While many existing studies report that corporate diversification destroys shareholder value, two recent studies challenge these findings. Schoar (2002) finds that plants in conglomerates are more productive than those in comparable single-segment firms, although conglomerates are traded at discounts. Villalonga (2004) employs a more comprehensive database than that used in the existing studies, and shows that there is a significant diversification premium, rather than discount. This paper develops a model that highlights the costs and benefits of corporate diversification. The diversified firm trades off the benefits of more efficient resource allocation through its internal capital market against the costs of information rents to division managers, which are necessary for effective workings of the internal capital market. We provide an argument supporting Schoar's findings, and identify conditions under which there can be a diversification discount or a premium.

JEL Classification: G300, J300

Keywords: Diversification discount, information rents, internal capital market, multidivisional firm, single-segment firm

* Please send all correspondence to: Chongwoo Choe, Australian Graduate School of Management, University of New South Wales, Sydney, NSW 2052, Australia. Tel: 61-2-9931-9528, Fax: 61-2-9931-9326. Email: c.choe@agsm.edu.au.

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1. INTRODUCTION

The benefits and costs of corporate diversification have been the subject of extensive research.[1] Diversified firms can rely on internal capital markets that enable them to pool and reallocate corporate resources more efficiently through 'winner picking' than through external financing (Williamson (1975), Stein (1997)). They may also enjoy economies of scope, and gain strategic benefits by extending market power from one segment to another, and by facilitating tacit collusion through multi-market interactions. On the other hand, corporate diversification can exacerbate managerial agency problems (Jensen, 1986, 1993). How do these benefits and costs weigh up against each other? When are diversified firms more likely to perform better or worse than their stand-alone counterparts?

Earlier empirical studies on the effect of corporate diversification on firm performance find that diversified firms tend to have lower Tobin's Q, and are traded at discounts of up to 15 percent relative to comparable profiles of single-segment firms (Lang and Stulz (1994), Berger and Ofek (1995), Servaes (1996)). This has been known as the diversification discount, confirming the conventional wisdom that corporate diversification destroys shareholder value. Several theoretical studies offer explanations of the diversification discount based on agency theory (for example, Stulz (1990), Matsusaka and Nanda (2002)). They argue that the free cash flow problem can be more severe in conglomerates since they have larger investment opportunities and more accessible resources

[1] See, for example, Martin and Sayrak (2003) for a survey of the literature. Throughout the paper, we use the term 'diversified firms' interchangeably with 'multidivisional firms' or 'conglomerates'.

to do so if diversification can relax budget constraints imposed by imperfect capital markets. Although this theory focusing on the agency problem at the level of CEOs can explain overinvestment, it cannot address the issue of fund misallocation within conglomerates.

To analyze resource allocation within multidivisional firms, several studies look at the internal capital market of a multidivisional firm and identify the source of inefficient cross-subsidization. Scharfstein and Stein (2000) present a model illustrating the interaction between the CEO and the division managers within a multidivisional firm where both the CEO and the division managers enjoy private benefits of control by remaining on the job. In their model, the manager of a weak division has a lower opportunity cost of rent-seeking than the manager of a strong division. By rent-seeking, the manager of a weak division can increase bargaining power, to which the CEO reacts by distorting capital budgeting allocations in favor of the weak division. In Rajan et al. (2000), internal power struggles in diversified firms lead to misallocation of resources. When the divisions are similar in their resources and investment opportunities, there is no distortion in resource allocation. However, when the divisions are sufficiently diversified, the struggles result in resources flowing toward the most inefficient division, because it makes the weak division behave more cooperatively in joint production with other divisions.[2] Inderst and Laux (2001) show how competition for scarce corporate resources can enhance managerial incentives to work hard when the divisions are symmetric in cash endowments and growth potentials. But when the divisions are asymmetric, competition may reduce incentives for some managers and lower total firm value. In sum, one can take these explanations as a possible answer for the diversification discount, which is positively related to the extent to which the divisions are asymmetric in their resources and investment opportunities.

[2] Shin and Stulz (1998) report evidence on inefficient cross-subsidization within conglomerates.

However, more recent empirical studies question the interpretation and the findings of the earlier studies on the diversification discount. While the diversification discount can be real, the discount could be due to a selection bias: the firms that diversify are traded at discounts prior to diversification, and the firms acquired by conglomerates are traded at discounts before acquisition (Lamont and Polk (2001), Graham et al. (2002), Campa and Kedia (2002)). Moreover, other studies go on further showing that diversification can create shareholder value or lead to higher productivity at plant level. Villalonga (2004) shows how typical studies based on reported business segment data can understate the extent of diversification. Using the more comprehensive Business Information Tracking Series, she reports that diversified firms are traded at a significant premium. Schoar (2002) reports that plants in diversified firms are more productive than those in comparable single-segment firms, although conglomerates are traded at an average discount.[3] She conjectures that rent dissipation is responsible for this discrepancy and offers suggestive evidence that conglomerates pay higher wages to their employees.[4]

Given that the empirical evidence on the diversification discount is at best mixed, it is necessary to develop a model that can clarify the costs and benefits of corporate diversification, and identify conditions that lead to a diversification discount or a premium. Our paper addresses this issue by studying investment decisions in a multidivisional firm. Our key argument is that local information held by division managers is crucial for efficient workings of internal capital markets. However, communication of local information is costly: division managers should be given incentives to truthfully communicate their local

[3] Maksimovic and Phillips (2002) report a mixed result. They find that whether plants in conglomerates are more productive depends on plant size.

[4] Rose and Shepard (1997) also find that "the CEO of a firm with two lines of business averages 13% more in salary and bonus than the CEO of a similar-sized but undiversified firm, ceteris paribus" (p. 469).

information, which takes the form of information rents. Thus a multidivisional firm trades off the benefits of internal capital markets against the costs of information rents accrued to division managers for communication of their private information.

For illustrative purpose, consider two operating divisions, which can be incorporated either separately to form two stand-alone firms or jointly to form a conglomerate. We assume that investment is constrained by firms' own internal resources or limited capital that can be raised through imperfect external capital markets. Thus each stand-alone firm has its investment fund limited to its own resources. But the conglomerate can pool the resources available in both divisions, thereby breaking the budget constraint for a division with a superior investment opportunity.[5] This represents a potential advantage of the conglomerate over the stand-alone firms. Each division is run by a division manager, who has private information about the state of his division. The CEO of the conglomerate has the authority to pool and reallocate divisional resources but her capital allocation decision depends on the report from the division managers about the states of their divisions. We assume that each division manager derives private benefits from running the division, which increase in the revenue from investment in the division.[6] The division managers have therefore incentives to misrepresent their investment opportunities in order to get more investment funds. But they cannot be penalized for lying due to limited liability. Thus incentive compatibility and limited liability require that the division managers be rewarded for truth-telling. Such information rents are the cost of using the internal capital market in the conglomerate. We show that the information rents are generally larger in the conglomerate than in stand-alone

[5] It is possible to consider the case where stand-alone firms can obtain additional funds from external capital markets. As long as the cost of external financing is higher than that of internal financing, our qualitative conclusions do not change.

[6] Assuming private benefits, although ad hoc, is a standard way of introducing conflict of interests in finance literature. See, for example, Scharfstein and Stein (2000), Aggarwal and Samwick (2003), and de Motta (2003).

firms. Thus the very advantage of internal capital market –pooling resources and picking a winner- is likely to result in higher operation costs. We identify conditions under which the benefits of internal capital market are outweighed by the costs of information rents. This feature of internal capital markets echoes Schoar's (2002) findings that conglomerates are more productive because of better resource allocation but less profitable because of higher wages paid to managers.

Our model shares with Wulf (2000) and Bernardo et al. (2004) the common feature that the division managers of a multidivisional firm have information advantage relative to the headquarters. In Wulf's model, the two divisions are asymmetric and the manager of the large and established division is more powerful, who can manipulate the information about uncertain returns of the small and new division, while the manager of the small division is a passive agent. The headquarters uses the capital budget to prevent the manager of the large division from engaging in influence activities. Bernardo et al. show how to jointly optimize capital budgeting and managerial compensation to control the agency problem in a multidivisional firm. As mentioned before, Scharfstein and Stein (2000) show, under the assumption of symmetric information, that the rent-seeking behavior of division managers can distort internal capital allocation. These studies do not concern the issue of differences in managerial compensation caused by different organizational structures. Moreover, there are no distortions in capital allocation in our model. Instead, the possible low profitability of the conglomerate is due to rent dissipation to division managers.

The rest of the paper is organized as follows. Section 2 provides a discrete investment example that delivers most of our insight. Section 3 develops a formal model of continuous investment that relaxes a number of restrictive assumptions in Section 2. In Section 4, the model is extended in two directions by including managerial efforts of implementing projects, and by introducing a further layer of agency problem at the level of those who monitor the division managers. The final section concludes the paper.

2. A Discrete Investment Example

Consider two divisions incorporated separately or jointly. These divisions are assumed to be symmetric in all aspects. Each division has an initial endowment of resources, $\bar{I}$, which can be used for investment.[7] The initial endowment can be the cash flow generated from the division's assets in place or the funds the division can raise from external capital markets.[8] Each division is run by a division manager, who has no ownership of the division but obtains private benefits from managing the division. The private benefits are assumed to be linear with factor φ in the revenue from the investment project that the division undertakes. The division managers maximize the expected value of their private benefits cum any monetary compensation, and they are protected by limited liability, which imposes a lower bound of zero on their compensation. The opportunity cost of capital is assumed to be zero throughout the paper.

Before we proceed with analysis, we briefly justify the assumption that that the divisions are symmetric in all aspects. First, Inderst and Laux (2001) argue that competition within a conglomerate can intensify division managers' incentives to work hard in a symmetric setting. But such an advantage of internal capital markets is likely to vanish in an asymmetric setting. Similarly, the asymmetry of divisions plays a key role in Rajan et al.

[7] To simplify analysis, we assume that the initial resource endowment imposes a budget restriction only on the investment. The payment to division managers is drawn from a separate "operating budget" (Scharfstein and Stein (2000)).

[8] It is thus possible that some projects with positive net present value may not receive sufficient funds because of the imperfections in external capital markets.

(2000), and power struggles between divisions do not lead to resource misallocation if divisions are sufficiently symmetric.[9] In contrast, our analysis shows that internal competition for scarce resources may lead to high information costs and low profitability even in a symmetric model. Second, symmetry simplifies algebra.

Each division has two investment opportunities. A safe project requires investment of $I_1 < \bar{I}$ and yields revenue $R_1 > I_1$ with certainty. A risky project requires investment of $I_2 > \bar{I}$ and its revenue depends on the state each division is in, such as macroeconomic conditions, industry-specific shocks, or the nature of investment project. We assume there are two possible states, good or bad, denoted by $j = g$ or b. The probability that a division is in the good state is denoted by p. The revenue from the risky project in state j is $R_2 > R_1$ with probability p^j and zero otherwise. The probability of yielding R_2 in the good state is greater than that in the bad state, i.e., $p^g > p^b$. We assume that all the probabilities are independent and exogenously given, and that the state of a division is the division manager's private information.[10] The outsiders of the division, including the CEO of the multidivisional firm or other board members, and the investors of the stand-alone firms, do not observe the state before an investment decision is made. This assumption is different from that used in the agency models by Rajan et al. (2000), Scharfstein and Stein (2000), and Inderst and Laux (2001). They assume information symmetry between the insiders and outsiders of a division.

[9] In a recent survey, Stein (2001) concludes that "the internal capital market is most likely to run into problems when the firm's divisions have sharply divergent investment prospects".

[10] Alternatively, we can let the probabilities depend on either the division manager's ability or private effort. We abstract away from adverse selection or moral hazard of this kind. Moral hazard is present in our model through the manager's private benefits of control. That the states of divisions are independent is for expositional simplicity. Insofar as they are exogenously given, it is straightforward to extend our results to the case of correlated states. In Section 3, we generalize the results to the case of correlated states.

The information asymmetry, which enables the division managers to capture information rents, is central in our example and the model in the next section.

In a separately incorporated division, its budget constraint implies that only the safe project is feasible since $I_1 < \bar{I} < I_2$, leading to a certain profit of $R_1 - I_1$. In a multidivisional firm, however, resources can be pooled and reallocated by the corporate headquarters, a feature of internal capital markets. We assume that the CEO of the multidivisional firm has the control right to reallocate the entire available resources, $2\bar{I}$, between the two divisions. To exercise her control right effectively, the CEO needs the information at the divisional level, which should be communicated from the division managers. Thus the investment decision in the multidivisional firm can be described by a mechanism: in stage 1, the CEO announces and commits to an investment policy and compensation to the division managers, which depend on the report from the division managers;[11] in stage 2, each division manager communicates his private information to the CEO, who then implements the announced investment policy and compensation to the division managers. The CEO maximizes aggregate expected profit less any compensation to the division managers.[12]

In the analysis below, we assume that $I_1 + I_2 > 2\bar{I} > I_2$ and $p^g R_2 - I_2 > 2(R_1 - I_1) > p^b R_2 - I_2$. The inequality $2\bar{I} > I_2$ implies that, by pooling both divisions' resources, the jointly incorporated firm can undertake the risky project which is infeasible if the divisions are separately incorporated. This is the advantage of internal capital markets identified by, among others, Williamson (1975) and Stein (1997). The inequality $I_1 + I_2 > 2\bar{I}$ simplifies analysis by ruling out the possibility that the multidivisional firm can invest I_1 in the safe

[11] It is straightforward to verify that the revelation principle applies in this setting. Thus there is no loss of generality in focusing attention to a direct revelation mechanism.

[12] The case where the CEO is not a profit maximizer is discussed in Section 4.

project in one division and I_2 in the risky project in the other. The condition $p^g R_2 - I_2 > 2(R_1 - I_1) > p^b R_2 - I_2$ implies that, if one division is in the good state, then the multidivisional firm can maximize profit by investing I_2 in that division and leaving the other division (even if it is also in the good state) without investment. On the other hand, if both divisions are in the bad state, then each should obtain I_1 for investment in the safe project. These assumptions lead to the following first-best investment policy for the multidivisional firm: if both divisions are in the good state, then a division is randomly chosen for investment in the risky project;[13] if only one division is in the good state, then that division is chosen for the risky project; if both divisions are in the bad state, then both of them invest in the safe project.

Whether the CEO of the multidivisional firm can implement the first-best investment policy depends on her knowledge of the states facing the two divisions. The division managers enjoy private benefits from investment and more investment is available for a division under the umbrella of the multidivisional headquarters. Thus each division manager, despite the true state of his division, would have incentives to misrepresent its true state if there is no compensation for truth-telling. Let $w^j \geq 0$ denote the payment to a division manager when he reports that his division is in state j. Note that we assume limited liability and that other payments to the division managers are ignored since our focus is on information rents. However, our results remain valid even if there are additional revenue-based payments. This is shown in the appendix.

We spell out below the incentive compatibility constraints that guarantee that both division managers truthfully report their states in Nash equilibrium given the first-best investment policy. Suppose both divisions are in the good state. Then truth-telling leads to the division manager's expected payoff of $w^g + 0.5p^g \varphi R_2$ while a false report when the other

[13] Without loss of generality, we assume in this case that each division is given I_2 with probability ½.

division manager tells the truth leads to the payoff of w^b. Recall that the manager's private benefits are φR_2 when the revenue in his division is R_2. Thus truth-telling is the best response to truth-telling if

$$w^g + 0.5p^g \varphi R_2 \geq w^b. \tag{1}$$

Next, if only one of the divisions is in the good state, then the incentive compatibility constraint for the manager in the good-state division is

$$w^g + p^g \varphi R_2 \geq w^b + \varphi R_1, \tag{2}$$

while that for the manager in the bad-state division is

$$w^b \geq w^g + 0.5p^b \varphi R_2. \tag{3}$$

Finally, the incentive compatibility constraint when both divisions are in the bad state is

$$w^b + \varphi R_1 \geq w^g + p^b \varphi R_2. \tag{4}$$

The above inequalities are reduced to

$$\max\{0.5p^b \varphi R_2,\ \varphi(p^b R_2 - R_1)\} \leq w^b - w^g \leq \min\{0.5p^g \varphi R_2,\ \varphi(p^g R_2 - R_1)\}. \tag{5}$$

Since the managers are risk neutral, we can let $w^g = 0$ without loss of generality. Moreover, since the CEO maximizes profit less managerial compensation, she would choose a minimum w^b that satisfies (5) given $w^g = 0$. Denoting it by w_J, we have

$$w_J = \max\{0.5p^b \varphi R_2,\ \varphi(p^b R_2 - R_1)\}. \tag{6}$$

The payment w_J in (6) represents the information rent that the division manager enjoys in the multidivisional firm. The information rent increases as the division manager's private benefits increase and the revenue from risky project increases.

Let us define pre-compensation profit as revenue minus investment cost, which measures the efficiency of resource allocation in our setting. Since the probability of a division being in the good state is p and the states of the two divisions are independent, the expected pre-compensation profit of the multidivisional firm is equal to

$$p^2(p^gR_2 - I_2) + 2p(1 - p)(p^gR_2 - I_2) + 2(1 - p)^2(R_1 - I_1). \tag{7}$$

Since $p^gR_2 - I_2 > 2(R_1 - I_1)$ by assumption, the expected pre-compensation profit is larger than the total pre-compensation profits of the two separate divisions, $2(R_1 - I_1)$. Thus the multidivisional firm is more efficient than single-segment firms in resource allocation. However, the expected profit of the multidivision firm less information rents, denoted $E\pi_J$, is equal to

$$\begin{aligned} E\pi_J &= p^2(p^gR_2 - I_2) + 2p(1 - p)(p^gR_2 - I_2) + 2(1 - p)^2(R_1 - I_1) - 2(1 - p)w_J \\ &= p(2 - p)(p^gR_2 - I_2) + 2(1 - p)^2(R_1 - I_1) - 2(1 - p)w_J. \end{aligned} \tag{8}$$

It is not hard to see that $E\pi_J$ is smaller than the total profits of the two separate divisions, $E\pi_S = 2(R_1 - I_1)$, if and only if

$$p(2 - p)[(p^gR_2 - I_2) - 2(R_1 - I_1)] \leq 2(1 - p)w_J. \tag{9}$$

In (9), $(p^gR_2 - I_2) - 2(R_1 - I_1)$ is the difference in pre-compensation profits between the multidivisional firm and separately incorporated divisions when at least one division is in the good state. It represents the advantage of internal capital markets over separately incorporated divisions in pooling resources and relaxing divisional budget constraints. As noted earlier, w_J is the information rent that the multidivisional headquarters needs to incur to elicit the local information from each division. Then (9) implies that the multidivisional firm is more likely to be less profitable than its stand-alone counterparts when the probability of good state is smaller, the advantage of the large project over the small project is less significant and/or the information rents are larger.

Two observations emerge from this example. First, ceteris paribus, the managers of multidivisional firms are paid more than those of stand-alone firms due to the information rents they enjoy. Second, the profitability of multidivisional firms can be lower than their stand-alone counterparts although they are more efficient in the sense that their investment can generate larger pre-compensation profits. In short, there are costs and benefits to choosing a multidivisional structure. The main benefits come from the use of internal capital markets that relax divisional budget constraints, thereby enabling the multidivisional firm to enlarge its feasible investment set and reallocate pooled resources more efficiently than separately incorporated firms. These benefits are traded off against the information rents that are necessary to motivate the division managers to truthfully report their local information. These observations are consistent with Schoar's (2002) finidngs that conglomerates are more productive at the plant level but they are traded at a discount in stock markets, and employees in conglomerates are paid higher.

Three questions can be raised. First, do our results crucially depend on the lumpiness of investment? In our example, investment can be undertaken only at two levels, and the budget constraints for the separate divisions eliminate one investment opportunity. This leaves each division only one feasible choice so that the investors of separate divisions need not monitor managers' investment decisions. Although zero information rent in separate divisions is an extreme case due to the lumpiness of investment in our example, the feature that separate divisions incur lower information rents than joint divisions emerges in a more general model. This is shown in the next section.

Second, why cannot the CEO of the multidivisional firm mimic the resource allocation of separately incorporated divisions? More specifically, we have seen that using information elicited from the division managers and reallocating resources to a more efficient project does not yield the maximum expected profit if (9) holds. So, why wouldn't the CEO simply allocate I_1 to each division? Two reasons may prevent the CEO from doing so. First, to check that condition (9) holds, the CEO needs to know the probability of a division being in the good state. If the CEO lacks this information and overestimates p, she would believe that concentrated resource allocation to one division is more profitable than diversified resource allocation.[14] The second and probably more plausible reason is that the CEO may not maximize profit in determining resource allocations. Instead she may be a revenue maximizer or she can also derive private benefits from larger revenue. In this case, the CEO would be willing to incur the costs of eliciting local information to justify her investment decision, even though it may reduce profit.

The third question concerns why the CEO cannot gather information about the state of each division by herself. An implicit assumption in our example is that her information gathering cost is prohibitively large. Even if it is not, she may prefer using the investor's money to elicit the local information to doing it herself. Moreover, if the CEO can acquire information independently and overrule the division manager's proposal, it can reduce the division manager's incentives for information gathering (Aghion and Tirole (1997), Burkart et al. (1997)). Stein (2002) also highlights the inferiority of internal capital markets based on such an adverse effect of CEO monitoring. Whether this is indeed a case depends, among others, on the details of CEO compensation and her incentives. Since this is not our focus, we take the information asymmetry as given.

3. A MODEL WITH CONTINUOUS INVESTMENT

This section generalizes the results obtained in the previous section in a number of directions, including the case where investment can be made in any continuous amount, and where the states of divisions are correlated. As before, each division has an endowment of

[14] Overly optimistic assessments have been well documented in the corporate finance literature. For instance, Roll (1986) argues that mangers' overconfidence makes overpayment by acquiring firms in takeovers. Heaton (2002) demonstrates that managers decline positive net present value projects when they overestimate their firms' prospects.

initial resources $\bar{I}$. But the difference is now that each division has a continuum of investment opportunities denoted by $I \in (0, \infty)$. The revenue from investment is uncertain and represented by $R(I, s) + \varepsilon$, where $R(I, s)$ is twice-differentiable, increasing, concave in I with $R(0, s) = 0$, and ε is a random noise with zero mean and support $(-\infty, +\infty)$. State variable s assumes one of the two values, g and b, indicating a division is in a good or a bad state, respectively. That ε has a full support implies that the ex post observation of revenue does not reveal the level of investment, nor the true state each division is in. This assumption is partly to justify the contractual incompleteness we introduced in the previous section. Although revenue is public information conditional on the realization of state, only the division manager can observe its state.

For the multidivisional firm, we assume as before that the CEO requests the division managers' local information, determines their compensation and, based on the information communicated, chooses an investment policy. In separately incorporated divisions, however, each division manager is the *de facto* CEO of the stand-alone firm. Since we do not specify other details of CEO compensation, resource allocation in separately incorporated divisions becomes trivial unless the *de facto* CEO is properly monitored. Therefore we assume that the manager of the stand-alone firm is monitored by a party, the board for example, and call this party the monitor. The monitor plays the same role as the CEO of the multidivisional firm.[15]

Our focus is on the revelation mechanism that specifies the level of investment in each division and the division managers' compensation based on their report on the state of their divisions. The CEO of the multidivisional firm and the monitor of each single-segment firm maximize expected profits by choosing the levels of investment and the managers'

[15] Henceforth, we represent the division managers by the male gender pronoun and the other parties by the female gender pronoun.

compensation.[16] As before, we ignore any other compensation to the managers. We continue to assume that the opportunity cost of capital is zero, and the division managers enjoy private benefits which are linear with factor φ in the revenue from investment.

In what follows, we maintain the assumptions: (1) $\partial R(I, g)/\partial I > \partial R(I, b)/\partial I > 0$; (2) $\lim_{I \to +0} \partial R(I,s)/\partial I > 1$ and $\lim_{I \to +\infty} \partial R(I,s)/\partial I < 1$ for $s = g, b$. Assumption 1 implies that the marginal revenue of investment is positive and larger in the good state than in the bad state. This along with the concavity of $R(I, s)$ ensure that, for the same amount of investment, the expected revenue in the good state is larger than that in the bad state (i.e., $R(I, g) > R(I, b)$). Assumption 2 guarantees the existence and uniqueness of an interior solution: the first inequality implies that zero investment is strictly dominated by a small, positive amount of investment; the second inequality implies that the net return on investment is negative for a sufficiently large amount of investment.

Define I_g^* and I_b^* as the levels of investment that maximize profits in each state. That is, they are determined by the first-order conditions, $\partial R(I_g^*, g)/\partial I = 1$ and $\partial R(I_b^*, b)/\partial I = 1$. Note that assumption 1 implies $I_g^* > I_b^*$. Since the division managers enjoy private benefits from larger projects, they are inclined to state that their division is in the good state unless they are given proper incentives for truth-telling.

3.1. Analysis of separately incorporated divisions

Consider first the case each division is a separate, independent firm. To determine the optimal level of investment, the monitor needs the manager's private information. Since the

[16] Since each state corresponds to a unique level of optimal investment in a division, the manager's report can be also interpreted as a recommendation for investment. Given that the manager's compensation is designed in an incentive-compatible way, the managers have real authority while the monitors retain formal authority (Aghion and Tirole, 1997).

manager has incentives to report the good state, the monitor needs to pay him for reporting the bad state, which is denoted by w_S. As in the case of discrete example, we can set the compensation for reporting the good state equal to zero, and only the incentive compatibility constraint for reporting the bad state is binding. We divide the analysis into two cases.

Case (S.1): $\bar{I} \leq I_b^*$. In this case, investing all available resources maximizes profits regardless of the state a division is in. Thus there is no need for the information rent.

Case (S.2): $\bar{I} > I_b^*$. The profit-maximizing investment level is $\bar{I}_g \equiv \min\{\bar{I}, I_g^*\}$ if the division is in the good state and I_b^* otherwise. Thus the incentive compatibility constraint can be written as

$$w_S = \varphi[R(\bar{I}_g, b) - R(I_b^*, b)]. \tag{10}$$

3.2. Analysis of multidivisional firm

When the two divisions are jointly incorporated, the CEO of the multidivisional firm pools and reallocates divisional resources based on the report from the division managers. As before, the CEO is assumed to maximize expected profits for the organization as a whole. Moreover we continue to assume that the CEO implements the first-best investment policy by playing the revelation game described in the previous section. The case where the CEO has other objectives will be discussed in the next section. Let w_J be the payment to the manager for reporting the bad state. Again we divide the analysis into two cases.

Case (J.1): $\bar{I} < (I_b^* + I_g^*)/2$. In this case, if the two divisions are in the same state, then the CEO allocates resources equally between the two divisions.[17] Since $\bar{I} \leq I_g^*$, each

[17] Here we rule out the possibility of corner solution, i.e., the optimum where marginal revenues of the two divisions are not equal. It is not difficult to see that the existence of corner solution does not alter our analyses. The details are available upon request.

division is allocated $\bar{I}$ if both are in the good state, and $\bar{I}_b \equiv \min\{\bar{I}, I_b^*\}$ if both are in the bad state. When the two divisions are in different states, then the CEO allocates I_g to the good-state division and I_b to the bad-state division, where I_g and I_b are uniquely determined by

$$\partial R(I_g, g)/\partial I = \partial R(I_b, b)/\partial I \text{ s.t. } I_g + I_b = 2\bar{I}. \tag{11}$$

Then the incentive compatibility constraints for truthfully reporting the bad state are

$$\varphi R(\bar{I}_b, b) + w_J \geq \varphi R(I_g, b), \tag{12}$$

$$\varphi R(I_b, b) + w_J \geq \varphi R(\bar{I}, b). \tag{13}$$

Thus the optimal payment for reporting the bad state is given by

$$\begin{aligned} w_J &= \max\{\varphi R(I_g, b) - \varphi R(\bar{I}_b, b), \varphi R(\bar{I}, b) - \varphi R(I_b, b)\} \\ &= \varphi[R(I_g, b) - R(\bar{I}_b, b)] \end{aligned} \tag{14}$$

where the second equality is due to $\bar{I}_b \leq \bar{I}$, and $R(I, s)$ is increasing and concave in I.

Case (J.2): $\bar{I} \geq (I_b^* + I_g^*)/2$. In this case, the profit-maximizing investment policy is to invest $\bar{I}_g \equiv \min\{\bar{I}, I_g^*\}$ in each division if both are in the good state, and I_b^* if both are in the bad state. If the two divisions are in different states, then the optimal policy is to invest I_g^* in the good-state division and I_b^* in the bad-state division. Thus, the incentive compatibility constraints are

$$\varphi R(I_b^*, b) + w_J \geq \varphi R(I_g^*, b), \tag{15}$$

$$\varphi R(I_b^*, b) + w_J \geq \varphi R(\bar{I}_g, b). \tag{16}$$

Since $I_g^* \geq \bar{I}_g$, the optimal payment for reporting the bad state is

$$w_J = \varphi[R(I_g^*, b) - R(I_b^*, b)]. \tag{17}$$

3.3. Comparison of optimal investment, information rents, and profitability

We now compare the optimal investment and the managers' information rents in the two organizational structures, demonstrating that the insight from the discrete example carries through to a more general setting. First, we show that the multidivisional structure is more efficient than separately incorporated divisions in the sense that its pre-compensation profits are larger. However such an efficiency gain is traded off against larger information rents for the division managers.

Proposition 1. The managers' information rents are larger in the multidivisional firm than in separately incorporated divisions. Conditional on the realization of divisional states, pre-compensation profits in the multidivisional firm are larger than or equal to the sum of pre-compensation profits of separately incorporated divisions. Moreover, the division which is allocated larger investment resources is more efficient in that its investment yields larger pre-compensation profits.

Proof: See the Appendix.

The results in Proposition 1 are consistent with Schoar's (2002) empirical evidence that plants in conglomerates are more productive than plants in comparable single-segment firms but conglomerates pay higher wages. The last part of Proposition 1 is also consistent with the evidence in Maksimovic and Phillips (2002) that the main segments are more productive than peripheral segments within a conglomerate.

The intuition behind Proposition 1 can be offered as follows. The larger information rents in the multidivisional firm are due to larger incentives that the division managers have to misrepresent the state of their divisions. For instance, consider the case, $(I_b^* + I_g^*)/2 < \bar{I} <$

I_g^*. In separately incorporated divisions, misrepresenting the bad state as good increases investment in the division by $\bar{I} - I_b^*$. In the multidivisional firm, however, the same misrepresentation increases investment in the division by $I_g - I_b^*$.[18] Since $I_g > \bar{I}$, it is clear that the managers of the multidivisional firm can benefit more through misrepresentation. To counter such incentives, it is necessary to pay larger information rents.

On the other hand, the larger information rents in the multidivisional firm are necessary for more efficient investment. Consider again the case, $(I_b^* + I_g^*)/2 < \bar{I} < I_g^*$ and suppose that the two divisions are in different states. Then the sum of pre-compensation profits of separately incorporated divisions is equal to $R(\bar{I}, g) + R(I_b^*, b) - \bar{I} - I_b^*$ while the multidivisional firm's pre-compensation profit is $R(I_g, g) + R(I_b^*, b) - I_g - I_b^*$. Thus, by pooling the resources of the two divisions together, the multidivisional firm can realize an efficiency gain, $(R(I_g, g) - I_g) - (R(\bar{I}, g) - \bar{I})$. Such an efficiency gain is possible only if the division managers' information is utilized in investment decisions. This illustrates the costs and benefits of internal capital markets. When do the costs of information rents outweigh the benefits of efficiency gain in the multidivisional firm? The next proposition provides an answer to this question.

Proposition 2. Conditional on the realization of divisional states, the multidivisional firm generates the same post-compensation profits as their stand-alone counterparts (i) if both divisions are in the good state, or (ii) if the budget constraint is not binding (i.e., $\bar{I} > I_g^*$). But the multidivisional firm is less profitable (i) if both divisions are in the bad state and the budget constraint is binding in the good state (i.e., $\bar{I} < I_g^*$), or (ii) if the divisions are in different states and one of the following conditions holds:

[18] Here we assume that the other division is in the bad state, which is reported truthfully.

$$R(I_g,g)+R(I_b,b)-R(\bar{I},g)-R(\bar{I}_b,b)-\bar{I}+\bar{I}_b<\varphi[R(I_g,b)-R(\bar{I},b)] \quad \text{when } \bar{I}<(I_b^*+I_g^*)/2,$$
$$R(I_g^*,g)-R(\bar{I},g)-I_g^*+\bar{I}<\varphi[R(I_g^*,b)-R(\bar{I},b)] \quad \text{when } (I_b^*+I_g^*)/2\le\bar{I}<I_g^*.$$

Proof: See the Appendix.

Proposition 2 is a direct application of Proposition 1. If both divisions are in the same state or if the budget constraint is not binding, then the optimal investment policy is the same in both organizational structures. In this case, the multidivisional firm does not enjoy the efficiency gain from internal capital markets. Moreover since the managers have incentives to misrepresent the bad state as good, there are no information rents if both divisions are in the good state. Thus post-compensation profits are the same in both organizational structures. However if both divisions are in the bad state, then eliciting truthful information is more costly in the multidivisional firm, which results in lower post-compensation profits compared to its stand-alone counterparts. If the two divisions are in different states, then the multidivisional firm enjoys an efficiency gain from internal capital markets, although the information rents are larger. When the conditions in Proposition 2 hold, the efficiency gain is offset by the information rents, hence smaller post-compensation profits.

In the above propositions, performance was measured in terms of profits conditional on the realization of each state. A better measure of profitability may be the expected profits across all state realizations. In what follows, we compare the expected profits in the two organizational structures. Let p be the probability that a division is in the good state.

Proposition 3. If the states of divisions are independent, then the multidivisional firm has larger expected profits than its stand-alone counterparts if and only if

$$p[R(I_g,g)+R(I_b,b)-R(\bar{I},g)-R(\bar{I}_b,b)-\bar{I}+\bar{I}_b]>\varphi[R(I_g,b)-R(\bar{I},b)] \quad \text{when } \bar{I}<(I_b^*+I_g^*)/2,$$
$$p[R(I_g^*,g)-R(\bar{I},g)-I_g^*+\bar{I}]>\varphi[R(I_g^*,b)-R(\bar{I},b)] \quad \text{when } (I_b^*+I_g^*)/2\le\bar{I}<I_g^*.$$

The difference in expected profits ($E\pi_J - E\pi_S$) decreases in φ, and increases in p if $p < ½$ or $E\pi_J < E\pi_S$.

Proof: See the Appendix.

The conditions in Proposition 3 are analogous to (9) in the discrete case. The terms inside brackets on the left-hand side of the inequalities represent the efficiency gain for the multidivisional firm. The right-hand side of the inequalities is the extra information rent that the multidivisional firm incurs to realize the efficiency gain. Given this interpretation, it is straightforward to see why $E\pi_J - E\pi_S$ decreases in φ. As the division managers' private benefits increase, they have more incentives to misrepresent their private information, which need to be countered by larger information rents. This in turn reduces the advantage of the multidivisional firm over the stand-alone counterparts.

The last part of Proposition 3 shows how the incidence of information rent affects profitability. Suppose first $E\pi_J < E\pi_S$, implying that the information costs outweigh the benefits of efficiency gain in the multidivisional firm. Since the information rent is incurred when a division is in the bad state, an increase in p reduces the likelihood of bad state and accompanied information rent. Thus an increase in p improves the performance of the multidivisional firm, thereby reducing the gap between $E\pi_S$ and $E\pi_J$. However, the information rent is also incurred in separately incorporated divisions, which makes the relationship between p and $E\pi_J$ - $E\pi_S$ nonlinear. If $p < ½$ so that the bad state is more likely, then the information rent is significant in both organizational structures. In this case, an increase in p unambiguously favors the multidivisional firm.

So far we have assumed that the states of the two divisions are independent. This assumption is obviously restrictive since, for example, both divisions may be subject to a common shock. The following proposition extends Proposition 3 to the case of correlated states.

Proposition 4. Suppose that the states of the two divisions are correlated with the correlation coefficient ρ. Then in both organizational structures, the expected information rent is independent of ρ. The multidivisional firm has larger expected profits than its stand-alone counterparts if and only if

$$\begin{array}{ll} p(1-\rho)[R(I_g,g)+R(I_b,b)-R(\bar{I},g)-R(\bar{I}_b,b)-\bar{I}+\bar{I}_b]>\varphi[R(I_g,b)-R(\bar{I},b)] & \text{when } \bar{I}<(I_b^*+I_g^*)/2, \\ p(1-\rho)[R(I_g^*,g)-R(\bar{I},g)-I_g^*+\bar{I}]>\varphi[R(I_g^*,b)-R(\bar{I},b)] & \text{when } (I_b^*+I_g^*)/2\le\bar{I}<I_g^*. \end{array}$$

Moreover, the difference in expected profits ($E\pi_J - E\pi_S$) decreases in ρ.

Proof: See the Appendix.

The intuition behind the first part of Proposition 4 is as follows. For a given increase in the correlation coefficient, the increase in the probability of the two divisions being in different states is twice as large as the decrease in the probability of both divisions being in the bad state. On the other hand, since the information rent is paid only to the manager in the bad-state division, the information rent when the two divisions are in different states is a half of the rent when both divisions are in the bad state. Thus, the net effect of a change in the correlation coefficient on the expected information rent is zero regardless of whether the divisions are incorporated separately or jointly.

The correlation of divisional states affects profitability, however. As shown previously, the advantage of multidivisional firm over its stand-alone counterparts is its more efficient resource allocation when the divisions are in different states. The more the states are correlated, the less likely the divisions are in different states. This diminishes such an advantage. On the other hand, the expected information rent is invariant to the correlation of divisional states. Thus an increase in ρ decreases $E\pi_J - E\pi_S$. A further implication is possible if $|\rho|$ is interpreted as a measure of diversification in the multidivisional firm in that more diversified firms have divisions whose states are less correlated. Then Proposition 4 shows that diversification improves (harms) the multidivisional firm's profit performance relative to single-segment firms when the divisional states are positively (negatively) correlated. This is consistent with Wulf's (2000) empirical findings but in contradiction to the conclusions of Rajan et al. (2000), and Lamont and Polk (2002). The latter authors argue that diversification lowers the value of multidivisional firms. However, their interpretation of diversification differs from ours. In their analyses, diversification is measured by the standard deviation of investment within an industry. In our model, diversification implies lower correlation between divisional states. More interestingly, Proposition 4 shows that the direction of diversification – whether negative or positive correlation – is as important as diversification itself in assessing the effect of diversification on the performance of multidivisional firms.

4. Extensions of the Basic Model

Our basic model highlighted the tradeoff that multidivisional firms face between the efficiency gain of internal capital markets and information rents. Our analyses were conducted in a simple model where the division manager's only role is to communicate his private information to those who allocate resources, and those who allocate resources are motivated to maximize profits. In this section, we show that our main insight does not change if we relax the above features of the basic model. First, we include the division manager's effort costs to the basic model, which increase in the level of investment. While this mitigates the manager's incentives to misrepresent the bad state as the good state, suitably chosen compensations schemes lead to only slight modifications to our main results. Second, the CEO of the multidivisional firm or the monitors of separately incorporated divisions may be motivated by profits as well as revenue since they may also enjoy private benefits from empire-building. Models developed by Scharfstein and Stein (2000), for example, investigate the agency problem of CEOs and its interplay with the agency problem of division managers. Again our main results are shown to be robust to this change.

4.1. Effort costs of division managers

The basic model in the previous section ignores the implementation of investment projects. Suppose now that, after a division is allocated a certain amount of resources, the division manager has to exert private effort to implement the project.[19] The manager incurs disutility from his effort although effort is unverifiable hence cannot be contracted upon. Denote the manager's disutility of implementing an I-dollar project by $C(I)$ and assume that $C(I') - \varphi R(I', s) > C(I'') - \varphi R(I'', s) > 0$ for all $I' > I'' \geq 0$. This assumption means that the manager's disutility of effort is larger than his private benefits, and the more investment is committed in a division the greater is the difference. The consequence is that the manager now has incentives to misrepresent the good state as the bad state.[20] However this does not change the optimal investment policy. The only change now is that the information rent needs to be paid when the manager reports the good state. Corresponding to the four cases in the previous section, it is not hard to derive the information rent in each case as follows.

[19] To focus on our main issue of information rent, we ignore the effect of managerial effort on investment revenue although it is possible to model this. See, for example, Bernardo et al. (2001).

[20] If $C(I') - \varphi R(I', s) < C(I'') - \varphi R(I'', s) < 0$ for all $I' > I''$, then there are incentives for reporting the bad state as the good state. The analysis is thus similar to that of the basic model except that the information rent needs to be adjusted accordingly.

Case (S.1): $\bar{I} \le I_b^*$. $w_S = 0$.

Case (S.2): $\bar{I} > I_b^*$. $w_S = C(\bar{I}_g) - C(I_b^*) - \varphi[R(\bar{I}_g, g) - R(I_b^*, g)]$.

Case: (J.1): $\bar{I} < (I_b^* + I_g^*)/2$.

$$w_J = \max\{C(I_g) - C(\bar{I}_b) - \varphi[R(I_g, g) - R(\bar{I}_b, g)],\ C(\bar{I}) - C(I_b) - \varphi[R(\bar{I}, g) - R(I_b, g)]\}$$

$$= C(I_g) - C(\bar{I}_b) - \varphi[R(I_g, g) - R(\bar{I}_b, g)].$$ [21]

Case (J.2): $\bar{I} \ge (I_b^* + I_g^*)/2$. $w_J = C(I_g^*) - C(I_b^*) - \varphi[R(I_g^*, g) - R(I_b^*, g)]$.

It is easy to check that the above modification does not change Proposition 1. Propositions 2 to 4 need to be modified, but only slightly, as shown below.

Proposition 2′. Conditional on the realization of divisional states, the multidivisional firm generates the same post-compensation profits as their stand-alone counterparts (i) if both divisions are in the good state, or (ii) if the budget constraint is not binding (i.e., $\bar{I} > I_g^*$). But the multidivisional firm is less profitable (i) if both divisions are in the bad state and the budget constraint is binding in the good state (i.e., $\bar{I} < I_g^*$), or (ii) if the divisions are in different states and one of the following conditions holds:

$$\begin{array}{ll} R(I_g, g) + R(I_b, b) - R(\bar{I}, g) - R(\bar{I}_b, b) - \bar{I} + \bar{I}_b < C(I_g) - C(\bar{I}) - \varphi[R(I_g, g) - R(\bar{I}, g)] & \text{when } \bar{I} < (I_b^* + I_g^*)/2, \\ R(I_g^*, g) - R(\bar{I}, g) - I_g^* + \bar{I} < C(I_g^*) - C(\bar{I}) - \varphi[R(I_g^*, g) - R(\bar{I}, g)] & \text{when } (I_b^* + I_g^*)/2 \le \bar{I} < I_g^*. \end{array}$$

Proof: See the Appendix.

The proofs of Propositions 3' and 4' below are similar to those of Propositions 3 and 4 and are omitted.

[21] For the second equality, we need $C(I) - \varphi R(I, g)$ to be concave.

Proposition 3'. If the states of divisions are independent, then the multidivisional firm has larger expected profits than its stand-alone counterparts if and only if

$$p[R(I_g,g)+R(I_b,b)-R(\bar{I},g)-R(\bar{I}_b,b)-\bar{I}+\bar{I}_b]>C(I_g)-C(\bar{I})-\varphi[R(I_g,g)-R(\bar{I},g)] \quad \text{when } \bar{I}<(I_b^*+I_g^*)/2,$$
$$p[R(I_g^*,g)-R(\bar{I},g)-I_g^*+\bar{I}]>C(I_g^*)-C(\bar{I})-\varphi[R(I_g^*,g)-R(\bar{I},g)] \quad \text{when } (I_b^*+I_g^*)/2\le\bar{I}<I_g^*.$$

The difference in expected profits ($E\pi_J - E\pi_S$) decreases in φ, and increases in p if $p < ½$ or $E\pi_J < E\pi_S$.

Proposition 4′. If the correlation coefficient of the divisional states is ρ, then in both organizational structures, the expected information rent is independent of ρ. The multidivisional firm has larger expected profits than its stand-alone counterparts if and only if

$$p(1-\rho)[R(I_g,g)+R(I_b,b)-R(\bar{I},g)-R(\bar{I}_b,b)-\bar{I}+\bar{I}_b]>C(I_g)-C(\bar{I})-\varphi[R(I_g,g)-R(\bar{I},g)] \quad \text{when } \bar{I}<(I_b^*+I_g^*)/2,$$

$$p(1-\rho)[R(I_g^*,g)-R(\bar{I},g)-I_g^*+\bar{I}]>C(I_g^*)-C(\bar{I})-\varphi[R(I_g^*,g)-R(\bar{I},g)] \quad \text{when } (I_b^*+I_g^*)/2\le\bar{I}<I_g^*.$$

Moreover, the difference in expected profits ($E\pi_J - E\pi_S$), decreases in ρ.

4.2. Objectives of the CEO and monitors

The basic model assumes that the monitors of separate divisions and the CEO of multidivisional firm are driven by profit motives. However, similar to the division managers, they may also derive private benefits from the operation under their control. To consider this possibility, suppose now that their objectives are a weighted average of profit and revenue. Consider first the case in which they assign the weight η to profit and $1 - \eta$ to revenue where $0 \le \eta \le 1$. Define $I_g^*(\eta) \equiv \operatorname{argmax}\{\partial R(I, g)/\partial I = \eta\}$ and $I_b^*(\eta) \equiv \operatorname{argmax}\{\partial R(I, b)/\partial I = \eta\}$. Then it is easy to see that our results remain unchanged after replacing I_g^* and I_b^* by $I_g^*(\eta)$ and $I_b^*(\eta)$, respectively.

Perhaps a more plausible scenario could be that the monitors of separate divisions and the CEO of the multidivisional firm might have different objectives. If we interpret the monitor of a stand-alone firm as the board, the extent to which board members enjoy private benefits would be more limited compared to the CEO of the multidivisional firm. In an extreme case, one could assume that the monitors of separate divisions maximize profits while the CEO of the multidivisional firm maximizes a weighted average of profit and revenue. Again, it is possible to show that our main results remain unchanged. First, the analysis of separate divisions is the same as in our basic model. But in the analysis of the multidivisional firm, I_g^* and I_b^* must be replaced by by $I_g^*(\eta)$ and $I_b^*(\eta)$, respectively. More specifically, the CEO allocates $\min\{I_g^*(\eta), \bar{I}\}$ to each division if both divisions are in the good state, and $\min\{I_b^*(\eta), \bar{I}\}$ if both divisions are in the bad state. If the two divisions are in different states, then the CEO allocates $\min\{I_g^*(\eta), I_g\}$ to the division in the good state and $\min\{I_b^*(\eta), I_b\}$ to the other division. Because $I_g^*(\eta) > I_g^*$ and $I_b^*(\eta) > I_b^*$, it is clear that the CEO intends to overinvest when she obtains private benefits from investment. This deviation from profit maximization results in lower pre-compensation profits. However, its effect on the information rents is ambiguous and depends on the specification of the revenue functions.

5. Concluding Remarks

While many existing studies report that corporate diversification destroys shareholder value, two recent studies challenge these findings. Schoar (2002) finds that plants in conglomerates are more productive than those in comparable single-segment firms, although conglomerates are traded at discounts. She conjectures that rent dissipation may be responsible for this discrepancy and offers suggestive evidence that conglomerates pay higher wages to their employees. Moreover, Villalonga (2004) employs a more comprehensive database – the Business Information Tracking Series – and reports that there is a significant diversification premium, rather than a discount. The empirical evidence on the diversification discount is thus mixed at best, necessitating a theory that can balance the costs and benefits of corporate diversification and clarify the conditions that lead to a diversification discount or a premium.

This paper has developed a model that highlights the costs and benefits of corporate diversification. The diversified firm tends to be more efficient in resource allocation thanks to its internal capital market that breaks budget constraints for individual divisions. However, such benefits of internal capital market need to be traded off against the costs of information rents to division managers, which are necessary for effective workings of the internal capital market. When the latter outweighs the former, the diversified firm could be traded at discounts relative to single-segments firms despite its productive efficiency. This could be taken as an argument supporting Schoar's findings.

In our model, the source of the diversification discount is information rents rather than misallocation of resources within the multidivisional firm. More generally, one might argue that multidivisional firms are more prone to rent dissipation than focused firms either because of loss of control by the headquarters or because of higher wages paid to division managers. However, misallocation of resources due to influence activities within the multidivisional firm can be real as argued by a number of authors (Scharfstein and Stein (2000), Rajan et al. (2000), Inderst and Laux (2001)). Ultimately it is an empirical question how much the diversification discount is due to the inefficiency in resource allocation or rent dissipation. For multidivisional firms where neither of the above plays a significant role, the benefits of internal capital markets should lead to a diversification premium, rather than a discount.

APPENDIX

The case of revenue-based contract for division managers

Let $w^j \geq 0$ denote the payment to a division manager when he reports that his division is in state j. Let $w_i \geq 0$ be the additional payment when revenue is R_i, $i = 1, 2$. Since the managers are risk neutral and protected by limited liability, we can, without loss of generality, let the payment equal to zero in case the investment returns zero revenue. The incentive compatibility constraints corresponding to (1) to (4) can then be written as

$$w^g + 0.5p^g(\varphi R_2 + w_2) \geq w^b, \tag{1'}$$

$$w^g + p^g(\varphi R_2 + w_2) \geq w^b + \varphi R_1 + w_1, \tag{2'}$$

$$w^b \geq w^g + 0.5p^b(\varphi R_2 + w_2), \tag{3'}$$

$$w^b + \varphi R_1 + w_1 \geq w^g + p^b(\varphi R_2 + w_2). \tag{4'}$$

The above inequalities are reduced to

$$\max\{0.5p^b(\varphi R_2 + w_2),\ p^b(\varphi R_2 + w_2) - \varphi R_1 - w_1\}$$

$$\leq w^b - w^g \leq \min\{0.5p^g(\varphi R_2 + w_2),\ p^g(\varphi R_2 + w_2) - \varphi R_1 - w_1\}. \tag{5'}$$

Since the managers are risk neutral, we can again let $w^g = 0$ without loss of generality. Moreover, since the CEO maximizes profit less managerial compensation, she would choose a minimum w^b that satisfies (5'), given $w^g = 0$. Denoting it by w_J, we have

$$w_J = \max\{0.5p^b(\varphi R_2 + w_2),\ p^b(\varphi R_2 + w_2) - \varphi R_1 - w_1\}. \tag{6'}$$

As is clear from (6'), w_J is strictly positive regardless of the additional revenue-based pay. Thus the information rent is still incurred. The main reason for this is limited liability, without which either w^g or w_2 can be adjusted below zero to reduce the information rent.

Proof of Proposition 1

If $I_b^* < \bar{I}$, we have $w_S = 0$ and $w_J > 0$. Suppose $I_b^* \geq \bar{I}$. By definition, $\bar{I} \geq \bar{I}_g$ and $I_b \leq I_b^*$. Thus, $R(\bar{I}, b) - R(I_b, b) \geq R(\bar{I}_g, b) - R(I_b^*, b)$. Similarly, $R(I_g^*, b) - R(I_b^*, b) \geq R(\bar{I}_g, b) - R(I_b^*, b)$. Therefore (10), (14) and (17) lead us to $w_J \geq w_S$.

When the two divisions are in the same state, the optimal investment and pre-compensation profits are the same whether the divisions are incorporated separately or jointly. The difference emerges when the two divisions face different states. For separately incorporated divisions, the marginal revenue of investment for the division in the good state is greater than or equal to that of the division in the bad state: the optimal investment is $\bar{I}_g$ for the division in the good state and I_b^* for the division in the bad state. But the optimal investment in the multidivisional firm leads to the same marginal revenue for the two divisions. Thus the pre-compensations profits in the multidivisional firm are larger than or equal to the sum of pre-compensation profits of separately incorporated divisions.

In the multidivisional firm, the division in the good state is allocated more resources than the one in the bad state since $I_g > I_b$ (or $I_g^* > I_b^*$). Thus the division in the good state has larger pre-compensation profits: $R(I_g, g) - I_g > R(I_b, b) - I_b$, or $R(I_g^*, g) - I_g^* > R(I_b^*, b) - I_b^*$.

Proof of Proposition 2

If the two divisions are in the same state, then the optimal investment policy is the same in both organizational structures. Thus they have the same pre-compensation profits. In case both divisions are in the good state, no payment is necessary for truthful report, hence the same post-compensation profits. However, when both divisions are in the bad state, the information rent is larger in the multidivisional firm as shown in Proposition 1. Thus post-compensation profits are smaller in the multidivisional firm.

For the rest of the proposition, denote the post-compensation profits of the multidivisional firm by π_J, and the sum of post-compensation profits of the separately incorporated divisions by π_S. If the two divisions are in different states, then we have

$$\pi_S = \begin{cases} R(\bar{I}, g) + R(\bar{I}, b) - 2\bar{I} & \text{if } \bar{I} \le I_b^*, \\ R(\bar{I}_g, g) + R(I_b^*, b) - \bar{I}_g - I_b^* - \varphi[R(\bar{I}_g, b) - R(I_b^*, b)] & \text{if } \bar{I} > I_b^*, \end{cases}$$

$$\pi_J = \begin{cases} R(I_g, g) + R(I_b, b) - 2\bar{I} - \varphi[R(I_g, b) - R(\bar{I}_b, b)] & \text{if } \bar{I} < (I_b^* + I_g^*)/2, \\ R(I_g^*, g) + R(I_b^*, b) - I_g^* - I_b^* - \varphi[R(I_g^*, b) - R(I_b^*, b)] & \text{if } \bar{I} \ge (I_b^* + I_g^*)/2. \end{cases}$$

Therefore

$$\pi_J - \pi_S = \begin{cases} R(I_g, g) + R(I_b, b) - R(\bar{I}, g) - R(\bar{I}, b) - \varphi[R(I_g, b) - R(\bar{I}, b)] & \text{if } \bar{I} \le I_b^*, \\ R(I_g, g) + R(I_b, b) - R(\bar{I}, g) - R(I_b^*, b) - \bar{I} + I_b^* - \varphi[R(I_g, b) - R(\bar{I}, b)] & \text{if } I_b^* < \bar{I} < (I_b^* + I_g^*)/2, \\ R(I_g^*, g) - R(\bar{I}, g) - I_g^* + \bar{I} - \varphi[R(I_g^*, b) - R(\bar{I}, b)] & \text{if } (I_b^* + I_g^*)/2 \le \bar{I} < I_g^*, \\ 0 & \text{if } \bar{I} \ge I_g^*. \end{cases}$$

It follows that $\pi_J < \pi_S$ if and only if

$$\begin{aligned} &R(I_g, g) + R(I_b, b) - R(\bar{I}, g) - R(\bar{I}, b) < \varphi[R(I_g, b) - R(\bar{I}, b)] && \text{if } \bar{I} \le I_b^*, \\ &R(I_g, g) + R(I_b, b) - R(\bar{I}, g) - R(I_b^*, b) - \bar{I} + I_b^* < \varphi[R(I_g, b) - R(\bar{I}, b)] && \text{if } I_b^* < \bar{I} < (I_b^* + I_g^*)/2, \\ &R(I_g^*, g) - R(\bar{I}, g) - I_g^* + \bar{I} < \varphi[R(I_g^*, b) - R(\bar{I}, b)] && \text{if } (I_b^* + I_g^*)/2 \le \bar{I} < I_g^*. \end{aligned}$$

Proof of Proposition 3

Since the states of divisions are independent, the probability of both divisions being in the good state is p^2, one in the good state and the other in the bad state is $2p(1-p)$, and both in the bad state is $(1-p)^2$. Then the expected profits for each organizational structure can be written as

Case (S.1): $\bar{I} \le I_b^*$

$$E\pi_S = 2p^2 R(\bar{I}, g) + 2p(1-p)[R(\bar{I}, g) + R(\bar{I}, b)] + 2(1-p)^2 R(\bar{I}, b) - 2\bar{I}.$$

Case (S.2): $\bar{I} > I_b^*$

$$E\pi_S = 2p^2[R(\bar{I}_g, g) - \bar{I}_g] + 2p(1-p)[R(\bar{I}_g, g) + R(I_b^*, b) - \bar{I}_g - I_b^*] +$$

$$2(1-p)^2[R(I_b^*, b) - I_b^*] - 2(1-p)\varphi[R(\bar{I}_g, b) - R(I_b^*, b)].$$

Case (J.1): $\bar{I} < (I_b^* + I_g^*)/2$

$$E\pi_J = 2p^2[R(\bar{I}, g) - \bar{I}] + 2p(1-p)[R(I_g, g) + R(I_b, b) - 2\bar{I}] +$$

$$2(1-p)^2[R(\bar{I}_b, b) - \bar{I}_b] - 2(1-p)\varphi[R(I_g, b) - R(\bar{I}_b, b)].$$

Case (J.2): $\bar{I} \geq (I_b^* + I_g^*)/2$

$$E\pi_J = 2p^2[R(\bar{I}_g, b) - \bar{I}_g] + 2p(1-p)[R(I_g^*, g) + R(I_b^*, b) - I_g^* - I_b^*] +$$

$$2(1-p)^2[R(I_b^*, b) - I_b^*] - 2(1-p)\varphi[R(I_g^*, b) - R(I_b^*, b)].$$

Following the similar algebra as in the proof of Proposition 2, we obtain

$$E\pi_J - E\pi_S = \begin{cases} 2p(1-p)[R(I_g, g) + R(I_b, b) - R(\bar{I}, g) - R(\bar{I}_b, b) - \bar{I} + \bar{I}_b] \\ \qquad -2(1-p)\varphi[R(I_g, b) - R(\bar{I}, b)], \qquad \text{when } \bar{I} < (I_b^* + I_g^*)/2, \\ 2p(1-p)[R(I_g^*, g) - R(\bar{I}, g) - I_g^* + \bar{I}] - 2(1-p)\varphi[R(I_g^*, b) - R(\bar{I}, b)], \\ \qquad \text{when } (I_b^* + I_g^*)/2 \leq \bar{I} < I_g^*. \end{cases}$$

From the above follows the first part of the proposition, and $\partial(E\pi_J - E\pi_S)/\partial\varphi < 0$. To show the last part of the proposition, straightforward algebra leads to

$$\frac{\partial(E\pi_J - E\pi_S)}{\partial p} = \begin{cases} 2(1-2p)[R(I_g, g) + R(I_b, b) - R(\bar{I}, g) - R(\bar{I}_b, b) - \bar{I} + \bar{I}_b] \\ \qquad + 2\varphi[R(I_g, b) - R(\bar{I}, b)], \qquad \text{when } \bar{I} < (I_b^* + I_g^*)/2, \\ 2(1-2p)[R(I_g^*, g) - R(\bar{I}, g) - I_g^* + \bar{I}] + 2\varphi[R(I_g^*, b) - R(\bar{I}, b)], \\ \qquad \text{when } (I_b^* + I_g^*)/2 \leq \bar{I} < I_g^*. \end{cases}$$

Since the sums of the terms inside brackets are positive, it is immediate that $\partial(E\pi_J - E\pi_S)/\partial p > 0$ if $p < ½$ or $E\pi_J - E\pi_S < 0$.

Proof of Proposition 4

Let s_A and s_B be the random variables representing the states of the two divisions. Following Inderst and Müller (2003), let $\Pr(s_A = g, s_B = g) = p - q$, $\Pr(s_A = g, s_B = b) = \Pr(s_A = b, s_B = g) = q$, and $\Pr(s_A = b, s_B = b) = 1 - p - q$. Then, $\rho = Cov(s_A, s_B)/[Var(s_A)Var(s_B)]^{1/2} = 1 - q/p(1 - p)$, which leads to $q = p(1 - p)(1 - \rho)$. Substituting q into the above, the probability of both divisions being in the good state is $p[1 - (1 - p)(1 - \rho)]$, one in the good state and the other in the bad state is $2p(1 - p)(1 - \rho)$, and both in the bad state is $(1 - p)[1 - p(1 - \rho)]$.

In both organizational structures, only the manager of the division in the bad state receives the information rent. Denoting the information rent by w, the expected information rent is $Ew = 2(1 - p)[1 - p(1 - \rho)]w + 2p(1 - p)(1 - \rho)w = 2(1 - p)w$, which is independent of ρ as claimed.

Next, replacing p^2, $2p(1 - p)$, and $(1 - p)^2$ by the above probabilities in the pre-compensation profits in the proof of Proposition 3, we obtain

$$E\pi_J - E\pi_S = \begin{cases} 2p(1-p)(1-\rho)[R(I_g,g)+R(I_b,b)-R(\bar{I},g)-R(\bar{I}_b,b)-\bar{I}+\bar{I}_b] \\ \qquad -2(1-p)\varphi[R(I_g,b)-R(\bar{I},b)], \qquad \text{when } \bar{I} < (I_b^*+I_g^*)/2 \\ 2p(1-p)(1-\rho)[R(I_g^*,g)-R(\bar{I},g)-I_g^*+\bar{I}]-2(1-p)\varphi[R(I_g^*,b)-R(\bar{I},b)], \\ \qquad \text{when } (I_b^*+I_g^*)/2 \le \bar{I} < I_g^* \end{cases}$$

From the above follows the rest of the proposition.

Proof of Proposition 2′

When the two divisions are in the same state, the proof is the same as that of Proposition 2. When the divisions are in different states, we have

$$\pi_S = \begin{cases} R(\bar{I},g)+R(\bar{I},b)-2\bar{I} & \text{if } \bar{I} \le I_b^*, \\ R(\bar{I}_g,g)+R(I_b^*,b)-\bar{I}_g-I_b^*+\varphi[R(\bar{I}_g,g)-R(I_b^*,g)]-C(\bar{I}_g)+C(I_b^*) & \text{if } \bar{I} > I_b^*, \end{cases}$$

$$\pi_J = \begin{cases} R(I_g,g)+R(I_b,b)-2\bar{I}+\varphi[R(I_g,g)-R(\bar{I}_b,g)]-C(I_g)+C(\bar{I}_b) & \text{if } \bar{I} < (I_b^*+I_g^*)/2, \\ R(I_g^*,g)+R(I_b^*,b)-I_g^*-I_b^*+\varphi[R(I_g^*,g)-R(I_b^*,g)]-C(I_g^*)+C(I_b^*) & \text{if } \bar{I} \ge (I_b^*+I_g^*)/2, \end{cases}$$

$$\pi_J - \pi_S = \begin{cases} R(I_g,g) + R(I_b,b) - R(\bar{I},g) - R(\bar{I},b) + \varphi[R(I_g,g) - R(\bar{I},g)] - C(I_g) + C(\bar{I}), & \text{if } \bar{I} \le I_b^*, \\ R(I_g,g) + R(I_b,b) - R(\bar{I},g) - R(I_b^*,b) - \bar{I} + I_b^* + \varphi[R(I_g,g) - R(\bar{I},g)] - C(I_g) + C(\bar{I}) & \text{if } I_b^* < \bar{I} < (I_b^* + I_g^*)/2, \\ R(I_g^*,g) - R(\bar{I},g) - I_g^* + \bar{I} + \varphi[R(I_g^*,g) - R(\bar{I},g)] - C(I_g^*) + C(\bar{I}) & \text{if } (I_b^* + I_g^*)/2 \le \bar{I} < I_g^*, \\ 0 & \text{if } \bar{I} \ge I_g^*. \end{cases}$$

Rearranging the terms gives us the proposition.

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