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Reallocation of corporate resources and managerial incentives in internal capital markets

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Abstract

Diversified firms often trade at a discount with respect to their focused counterparts. The literature has tried to explain the apparent misallocation of resources with lobbying activities or power struggles. We show that diversification can destroy value even when resources are efficiently allocated ex post. When managers derive utility from the funds under their purview, moving funds across divisions may diminish their incentives. The ex ante reduction in managerial incentives can more than offset the increase in firm value due to the ex post efficient reallocation of funds. This effect is robust to the introduction of monetary incentives. Moreover we show that asymmetries in size and growth prospects increase the diversification discount.

JEL classification: G31; L20

Keywords: Internal capital markets; Conglomerates; Managerial incentives

1. Introduction

The analysis of the allocation of funds among different divisions of a conglomerate firm is a relatively young topic. Stein (2002b) provides a recent survey. The general theme coming from the empirical literature is that diversified firms trade on average at a discount relative to a portfolio of focused firms in the same industries, as reported by Berger and Ofek (1995), Servaes (1996) and Lins and Servaes (1999). Moreover, the 1980s saw a process of dismantling of diversified firms, driven by the idea that the divisions would be more efficiently managed as stand-alones. But if there is by now a

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wide consensus on the idea that a diversification discount exists, it is much less clear why this is the case.

Stein (1997) has pointed out that internal capital markets can create value in financially constrained firms. In Stein's words, "*Simply put, individual projects must compete for scarce funds, and headquarters' job is to pick winners and losers in this competition.*" Stein denotes this activity of headquarters in a conglomerate firm as "winner-picking". Contrary to the empirical findings, Stein's model suggests that internal capital market should create value and thus a premium for diversified firms. One possible way to solve this apparent paradox is to argue that the discount of diversified firms is due to misallocation of resources in internal capital markets. For instance, Rajan et al. (2000) find that multi-segment firms allocate relatively more capital to "weak" lines of business than their stand-alone counterparts, and relatively less to segments in "strong" lines of business. Scharfstein (1998) finds that the investment of conglomerate divisions is virtually insensitive to investment opportunities, as measured by the industry q's. Lamont (1997) shows that resource allocation in diversified firms is different from that in focused firms and less sensitive to indicators of investment value such as Tobin's q.

However, the evidence on inefficient allocation of funds has been disputed. Whited (2001) points out that the inefficiency results appeared in the literature may actually be due to the incorrect measures adopted for the investment opportunities of the divisions. She shows that when measurement problems are taken into account, the evidence of inefficient allocation of funds disappears. Chevalier (2000) analyzes the investment behavior of a sample of firms before and after diversifying mergers, finding no evidence of a change in investment behavior. This implies that, if there is inefficiency in the investment behavior of the divisions of conglomerate firms, such inefficiency does not appear to be due to the presence of internal capital markets.

In this paper we argue that in order to explain the diversification discount we do not need to assume any misallocation of funds in internal capital markets. Conglomerates can destroy value even if resources are efficiently allocated. If managers derive utility from the funds under their purview, the possibility of implementing a "winner-picking" policy, while optimizing resources allocation ex post (i.e. after managerial effort has been exerted), reduces managerial incentives to exert effort. Taking away from the manager the cash flow generated by the division has the negative implication of reducing the incentives for division managers to spend effort to generate the cash flow. The reduced managerial incentives can more than offset the gains of reallocating funds to the most profitable divisions. In other words, "winner-picking" is both the bright and the dark side of internal capital markets.

We consider a two-period model with two divisions and a headquarters. Division managers receive private benefits in proportion to the gross return of the division they run. Headquarters maximizes total firm value. In the first period the two division managers have to exert a non-verifiable effort to increase the probability of success of a project already in place. The cash flow generated by the existing project will be reinvested inside the firm in the second period. Before the second period, the headquarters receives a signal on the second period profitability of the two divisions and reallocates funds. When divisions operate as stand-alones, each division reinvests the cash flow generated by the first period project. On the contrary, in the diversified firm the headquarters will redistribute the cash flow to the most profitable division. The redistribution has two effects: on one hand it creates value, but on the other hand it reduces the rent for the manager of the (ex post) less profitable division. Anticipating the possibility of being expropriated, each division manager will reduce his effort. Consequently, the total cash flow to be reinvested in period two will decrease.

This observation has the following implications. First, a profit-maximizing headquarters will face a time inconsistency problem. Once the funds are generated, headquarters would like to exercise "winner-picking" to the highest extent possible. However, this ex post maximizing behavior by headquarters will reduce ex ante incentives at the divisional level, and it may cause a loss of value for the corporation. When the gain from reallocating funds across divisions is limited, i.e. when "winner-picking" has a limited potential for creating value, the negative effect on the reduced managerial incentives dominates and the diversified firm trades at a discount. Conversely, when the gains obtained from reallocation of funds across divisions are large, then the advantages of "winner-picking" dominate over the reduced managerial incentives, and the diversified firm trades at a premium. [1]

Second, diversity in the ex ante profitability of divisions increases the likelihood that a conglomerate trades at a discount. If one division has a very high probability of having ex post the best investment opportunities, the incentives for the manager of the other division are reduced. Therefore the cash flow that can be reallocated to the most profitable division is also reduced, limiting the gains of "winner-picking".

Finally, the diversification discount is greater when a division with a greater potential for immediate cash generation is paired with a division with poor capacity of immediate cash generation but good growth prospects. In this case the manager of the first firm will fear expropriation of the cash flow generated in favor of the high-growth firm, thus reducing the conglomerate's value.

The basic intuition that ex post interference by the principal may be harmful for the agent's ex ante incentives is of course not new. For example, Aghion and Tirole (1997) show that if the principal intervenes too often in the decisional process, it can stifle the agent's initiative. Gertner et al. (1994) point out that giving control rights to capital providers in an internal capital market may be costly in that it diminishes managerial incentives. The manager of a division is more vulnerable to the opportunistic behavior by corporate headquarters than a manager of a firm receiving financing either from a bank or from an external financial market because headquarters have control rights over the division's assets. Contrary to a bank, headquarters can liquidate the assets even when the division performs well. In their model the hold up problem between headquarters and divisions holds irrespective of the possibility of reallocating resources across divisions. In our model it is precisely the "winner-picking" ability of the headquarters that blunts managerial incentives. [2] Rotemberg and Saloner (1994)

[1] It is not uncommon to observe diversified firms trading at a premium. Rajan et al. (2000) report that 39.3 percent of diversified firms in their sample traded at a premium in 1990.

[2] Stein (2002a) also points out that managers' incentives may be blunted when they do not have ultimate authority. However, his model addresses a different issue, namely how decentralized and hierarchical firms differ in terms of their ability to generate information about investment projects and allocate capital to these projects efficiently.

discuss how, in the presence of incomplete contracts, firms may benefit from restricting the scope of their activities. Their basic idea is that diversified firms have a wider range of projects to implement, and for some reason they cannot implement all of them. As a result, they are more likely to implement a project that it is not ideal for providing ex ante incentives. They also propose an application of their model to internal capital markets, showing that it may be optimal to force each division to use only funds that it has generated itself. We extend their argument pointing out the cases where internal capital markets are less likely to be beneficial.

Other papers which present arguments similar to ours include Gautier and Heider (2000), Inderst and Laux (2000), Inderst and Müller (2003) and De Motta (2003). Gautier and Heider (2000) analyzes a model in which division managers must first produce cash flow that will be then reinvested inside the company. However, in their model projects have a fixed size (an extreme version of decreasing marginal returns of capital) and consequently the scope for winner-picking is reduced. In Inderst and Laux (2000) effort is directed to the generation of investment opportunities rather than cash, and their focus is on the role played by liquidity constraints. Inderst and Müller (2003) is also focused on the impact of conglomerates on financing constraints. De Motta (2003) studies a model in which division managers try to influence the internal capital market's assessment of their division in order to boost their level of funding. In his model the difference between external and internal capital markets is the informational advantage of the latter, while in our model the distinctive feature is the headquarters' ability to reallocate funds across divisions and informational asymmetries do not play any role.

Mailath et al. (2002) apply a similar setting to study the cost of mergers. In their model there may be disadvantages in merging two firms even in the case when the merger allows the internalization of externalities between two firms. The reason is that the redeployment of assets implied by the merger can increase the cost of inducing managerial effort by making unprofitable certain decisions like the termination of an unprofitable project which has a positive externality on the other divisions. Hart and Holmström (2002) consider a firm with two divisions and compare two different organizational model. In one case decisions are taken at the divisions' level. The disadvantage of this model is that the division's manager does not take into account the externalities created to the other division. On the other hand, the advantage of the decentralized decision making is that the private benefits of the division are considered. When decision making is centralized the opposite occurs: total profits are considered, but no weight is put on the division's private benefits.

On the empirical side, a number of papers have tried to explain the "diversification discount" as the consequence of a non-random selection of firms that become conglomerate. Papers in this literature include Campa and Kedia (2002), Fluck and Lynch (1999) and Maksimovic and Phillips (2002). The general point is that weaker firms may have a comparative advantage in merging. Thus, even if conglomerate firms work efficiently, a diversification discount appears. Our point is different, and it is related to the different managerial incentives provided by conglomerate firms.

As a final remark, we stress that we do not want to argue that resources are indeed allocated efficiently in internal capital markets. Power struggles, influence activities etc.

are surely present in most corporations, and such inefficiencies contribute to reducing the value of diversification. Our point is that diversified firms may well trade at a discount *even if internal capital markets allocate funds efficiently*. The optimal policy ex post is not necessarily the optimal policy ex ante.

The paper is organized as follows. In Section 2 we describe the basic model. Section 3 illustrates the main effects of the "winner-picking" policy, comparing the performance of a diversified corporation in which funds are allocated ex post efficiently with the performance of a "stand alone" firm. In Section 4 we show that the basic results still hold when the firm can provide monetary incentives to the managers. Section 5 discusses the impact of asymmetry in size between the two divisions. Section 6 contains the conclusions, and an appendix collects the proofs.

2. The model

Our model has three agents: headquarters (H) and two division managers, M_1 and M_2. Each division has assets in place and new investment opportunities. Division managers derive private benefits from the assets of their divisions only, while headquarters is interested in total returns. The timing of the model is as follows.

- At $t = 0$ manager M_i works with the assets already in place in his division. The existing project can either succeed or fail. If it fails, it produces a cash flow equal to $C_i = 0$. If the project succeeds, the cash flow is $C_i = 1$. The probability of success is determined by the level of effort exerted by the manager. We assume that if the manager chooses a level of effort e_i, then the existing project is successful with probability e_i. The disutility of effort e_i is $\psi(e_i) = k(e_i^2/2)$, with k strictly positive.[3]
- At $t = 0.5$ the two managers and headquarters observe a signal s that provides information on the productivity of the investment projects available at $t = 1$ in the two divisions.
- At $t=1$ headquarters observes the cash flow produced by the two divisions, C_1 and C_2 and redistributes funds to the divisions. The old assets in place are fully depreciated. We assume that the firm has no access to external finance,[4] so that $C_1 + C_2$ is the total amount of funds that can be reinvested in period 2. Headquarters has the power to allocate funds across divisions in a diversified firm. We denote with K_i the funds assigned to division i. We assume that headquarters allocate all funds to the divisions, so that $K_1 + K_2 = C_1 + C_2$. This may be justified assuming that each division always has sufficiently profitable investment projects. Alternatively, we may assume that headquarters has a preference for empire-building.
- At $t = 2$ the investment in division i yields a cash flow[5] $K_i\tilde{R}_i$.

[3] Our main point about the decreased managerial incentives in internal capital markets would hold for any $\psi(e)$ increasing and convex.

[4] This (admittedly) extreme assumption allows us to focus on the case where funds are scarce and thus winner-picking has a higher potential to create value by reallocating resources across divisions.

[5] As in Scharfstein and Stein (2000), we assume that in the second period the divisional managers do not have to exert any effort. This is obviously non-essential.

For simplicity we will assume that the signal s can only take two values. If $s = s_1$ then the expected return in the first division is higher than in the second, that is $\mathrm{E}(\tilde{R}_1|s_1) > \mathrm{E}(\tilde{R}_2|s_1)$, while if $s = s_2$ the opposite occurs.[6] In order to simplify further we assume:

$$\mathrm{E}(\tilde{R}_1|s_1) = \mathrm{E}(\tilde{R}_2|s_2) = \bar{R}, \quad \mathrm{E}(\tilde{R}_2|s_1) = \mathrm{E}(\tilde{R}_1|s_2) = \underline{R}.$$

We define $\Delta = \bar{R} - \underline{R} > 0$ and assume $\underline{R} > 1$. The assumption $\underline{R} > 1$ implies that it is always optimal to reinvest the cash flow produced. At last, we define $p = \Pr(s{=}s_1)$, and assume $p \in (0,1)$. Given the assumption on the support of s, we have $\Pr(s{=}s_2) = 1 - p$.

Finally we need to specify the objective functions of the headquarters and of division managers. Headquarters maximizes total returns. Concerning division managers, we follow Stein (1997) and assume that each division manager receives private benefits of control that are proportional to the gross output of its division. More precisely, we assume that a division manager reaps private benefits equal to a fraction $\phi \in (0,1)$ of the cash flow generated by his division in the second period $K_i\tilde{R}_i$.[7] This assumption implies that each manager always prefers more capital to less, but conditional on being given a certain amount of capital each manager tries to invest it in the most profitable project available. In other words, managers are empire builders, but they prefer more profitable empires to less profitable empires. Furthermore, it is the possibility of reallocating resources across divisions that may create a divergence of interests between the headquarters and the division managers. Without the possibility of "winner-picking" there would be no conflict of interests between headquarters and divisions.

As it is common in this literature, we begin our analysis by assuming non-responsiveness of managers to monetary incentives. In Section 4, we consider the case in which monetary incentives can be provided.

Formally, the utility function of the manager of division i is given by

$$U(e_i, K_i, \tilde{R}_i) = \phi K_i \tilde{R}_i - k\,\frac{e_i^2}{2}.$$

For simplicity we assume that private benefits are psychic, that is they do not derive from "stealing" or misusing the company's assets.[8] As usual, private benefits can be thought of in a number of ways: the usual perks, the psychic benefits from empire building, etc. Finally, the risk-free interest rate is normalized to zero and all agents are risk neutral.

[6] Note that we assume that the profitability of each division in period 2 is exogenous. In a more general framework, the return on the investment of each division should be a function of both managerial effort and "luck". Then there would be a countervailing effect: competition for funds may boost managerial incentives. For a treatment of this case see Inderst and Laux (2000).

[7] We could alternatively assume that division managers derive private benefits also from the first period cash flow. This would not affect our results. The calculations for this case can be found in Brusco and Panunzi (2000).

[8] Given that we assume that private benefits are a constant fraction of the division's gross output, this assumption has no serious implications for the analysis. If private benefits were extracted at the expense of profits, the headquarters' profit should be multiplied by the constant $1 - \phi$.

3. The bright and the dark side of "winner-picking"

In this section we want to highlight the basic trade-off between incentive provision and ex post efficiency. We therefore consider two alternative "extreme" organizational forms: The "stand-alone" one, in which divisions are completely separated and no internal capital market exists, and the pure internal capital market one, in which capital is entirely assigned to the ex post most efficient division.

In the stand-alone case, by exercising effort e_i at $t = 0$ the manager of division i obtains an expected amount $e_i \cdot 1 + (1 - e_i) \cdot 0 = e_i$ of funds for reinvestment at time 1. Given the information at time 0, the expected cash flow generated by those funds at $t = 2$ is

$$[p_i(\underline{R} + \Delta) + (1 - p_i)\underline{R}]e_i = [\underline{R} + p_i\Delta]e_i,$$

where $p_1 = p$ and $p_2 = 1 - p$. The problem of M_i at time zero is

$$\max_{e_i} \phi[\underline{R} + p_i\Delta]e_i - k\,\frac{e_i^2}{2}.$$

The necessary and sufficient condition for a maximum is

$$e_i^{\mathrm{SA}} = \frac{\phi(\underline{R} + p_i\Delta)}{k}. \tag{1}$$

To obtain interior solutions for e_i we impose the following:

Assumption 1. $\underline{R} + \Delta < k$.

The sum of the expected profit under the stand alone solution is given by

$$\Pi^{\mathrm{SA}} = (\underline{R} + p\Delta)e_1^{\mathrm{SA}} + (\underline{R} + (1 - p)\Delta)e_2^{\mathrm{SA}}$$
$$= \frac{\phi}{k}[(\underline{R} + p\Delta)^2 + (\underline{R} + (1 - p)\Delta)^2].$$

Consider now the internal capital markets (ICM henceforth) case. Now headquarters observes s_i at time t=0.5 and then allocates entirely the funds to division i.[9] Therefore, division i faces a probability $1 - p_i$ of having zero funds and a probability p_i of having all funds. The total expected amount of funds is e_1+e_2. The problem for M_i is therefore:

$$\max_{e_i} \phi p_i(\underline{R} + \Delta)(e_i + e_{-i}) - k\,\frac{e_i^2}{2}$$

and the necessary and sufficient condition for a maximum is

$$e_i^{\mathrm{ICM}} = \frac{\phi p_i(\underline{R} + \Delta)}{k}. \tag{2}$$

The expected profit for headquarters is given by

$$\Pi^{\mathrm{ICM}} = (\underline{R} + \Delta)(e_1^{\mathrm{ICM}} + e_2^{\mathrm{ICM}}) = \frac{\phi}{k}(\underline{R} + \Delta)^2.$$

[9] This implication of our model is extreme and it is due to the assumption that the return to the investment in each division is linear. With decreasing marginal returns of investment, even the less profitable division could obtain a positive amount of funds.

We can now compare the expected profits under the pure ICM and stand alone forms. We have

$$\Pi^{\text{ICM}} - \Pi^{\text{SA}} = \Delta((1-p)e_1^{\text{ICM}} + pe_2^{\text{ICM}}) \\ -[(\underline{R} + p\Delta)(e_1^{\text{SA}} - e_1^{\text{ICM}}) + (\underline{R} + (1-p)\Delta)(e_2^{\text{SA}} - e_2^{\text{ICM}})]. \quad (3)$$

This can be read as follows. The term

$$\Delta((1-p)e_1^{\text{ICM}} + pe_2^{\text{ICM}})$$

represents the "winner-picking" effect. With probability $(1-p)$, the second division is the more profitable one. In the SA case, this does not lead to any extra funding for the firm. In the ICM case, division 2 obtains the cash generated by division 1, that is e_1^{ICM}. Expected profit therefore increases by $\Delta(1-p)e_1^{\text{ICM}}$. A similar effect is at work when division 1 is the more profitable. This term is the bright side of internal capital markets: Resources are ex post allocated to the best investment.

The key point of our paper is the second term. Notice that this term would be zero if we had $e_i^{\text{ICM}} = e_i^{\text{SA}}$. However, since

$$\frac{\phi p_i(\underline{R} + \Delta)}{k} < \frac{\phi(\underline{R} + p_i\Delta)}{k}$$

we have $e_i^{\text{ICM}} < e_i^{\text{SA}}$. This is the "incentive effect" denoting the reduction in expected profits as a consequence of the reduced incentives that managers have when funds are redistributed across divisions. In fact, the term $(\underline{R} + p_i\Delta)$ denotes the gross expected return on funds invested in the division, and the reduction in expected profit in division i is equal to the reduction in the amount of funds generated (that is, $e_i^{\text{SA}} - e_i^{\text{ICM}}$) times this return.[10]

The sign of $\Pi^{\text{ICM}} - \Pi^{\text{SA}}$ depends on the parameters as follows.

Proposition 1. (*a*) *For any given value of* p *and* $\underline{R}$ *there exists a value* Δ^* *such that if* $\Delta < \Delta^*$ *then* $\Pi^{\text{ICM}} - \Pi^{\text{SA}} < 0$, *while if* $\Delta > \Delta^*$ *then* $\Pi^{\text{ICM}} - \Pi^{\text{SA}} > 0$; (*b*) *for any given value of* Δ *and* $\underline{R}$ *the difference* $\Pi^{\text{ICM}} - \Pi^{\text{SA}}$ *is an increasing function of* p *on the interval* $(0, \frac{1}{2})$, *a decreasing function of* p *on the interval* $(\frac{1}{2}, 1)$ *and reaches its maximum at* $p = \frac{1}{2}$.

Part (a) states that when the divisions are expected to be ex post similar (Δ is small) there is not much point in reallocating funds, so that the predominant effect of internal capital markets is the reduction in incentives. In this case the diversified firm trades at

[10] In our model the loss of managerial incentives associated to internal capital markets depends on the possibility of losing private benefits when the cash flow is reallocated to the other division. Other modeling choices would lead to the same effect. For instance, we could assume that divisional managers must decide to invest in firm specific human capital that is lost when the division is shut down. Mailath et al. (2002) have instead a two-period model where the wage paid to managers depends on the division (firm, in their setting) performance on both periods. The optimal incentive scheme gives the manager a large payment when performance is high in both periods and a smaller reward otherwise. Thus if the division is shut down after the first period the manager loses the second period rent.

a discount with respect to the stand-alone benchmark.[11] As Δ increases reallocation creates more value, and the bright side of internal capital markets eventually prevails.

Part (b) addresses the issue of how ex ante differences in profitability between the two divisions lead to a higher or lower diversification discount (or premium). The advantage of the ICM form is at its maximum when the two divisions are ex ante identical. As the difference between divisions increases, the SA form becomes more appealing. To grasp the intuition, consider the case of p close to 1. Then the manager of division 1 is almost sure of obtaining all the funds in an internal capital market, whilst the manager of division 2 anticipates that it will obtain no funds almost surely. For division 1 incentives are as in the stand alone case. Moreover, since p is close to 1 winner-picking does not add much value. On the other hand, the incentives for the manager of division 2 are close to 0 in the case of the internal capital market, while her effort is positive in the stand alone case. Thus, internal capital markets are less desirable when divisions are very diverse.

One important assumption of our model is that there are constant returns for the investment. This implies that it is always optimal to reallocate all the funds to the division with the most profitable project. In the case of decreasing marginal returns the analysis would be different for two reasons. First, the gain from reallocating resources from one division to the other would be reduced. Second, given the reduced amount of winner-picking, the problem of reduced managerial incentives would be less serious. Therefore, the adverse effect on incentives would still be present, but to a lesser extent.

Remark. The negative impact of diversity on conglomerates has also been pointed out by Rajan et al. (2000). However, the measure of diversity they use is different, as they take into account the relative size of the divisions. Specifically, if we call λ_i the percentage of assets of division i with respect to the total amount of assets in the firm and R_i the expected gross return on investment in division i, the diversity between division i and j in Rajan et al. (2000) is given by

$$D = \frac{|\lambda_1 R_1 - \lambda_2 R_2|}{R_1 + R_2}.$$

In their empirical analysis, Rajan et al. (2000) show that the diversification discount increases when D increases.

In our model the assets are given by the cash produced for investment, an endogenous variable. If we look at the ratio between the expected amount of funds produced in division i and the total amount of funds produced in the conglomerate, we have

$$\lambda_i = \frac{\phi p_i(\underline{R} + \Delta)/k}{\phi(\underline{R} + \Delta)/k} = p_i.$$

Using $\lambda_1 = p,\ \lambda_2 = 1 - p,\ R_1 = \underline{R} + p\Delta$ and $R_2 = \underline{R} + (1-p)\Delta$, we obtain the following theoretical expression for diversity index in our model:

$$D = \frac{|p(\underline{R} + p\Delta) - (1-p)(\underline{R} + (1-p)\Delta)|}{2\underline{R} + \Delta} = 2\left|p - \frac{1}{2}\right|\left(\frac{\underline{R} + \Delta}{2\underline{R} + \Delta}\right).$$

[11] It is worth stressing at this point that, as all the papers in this literature, we do not analyze why there is no spin-off of the two divisions.

Thus, diversity increases either when the difference in expected profitability between divisions increases (that is, $|p - \frac{1}{2}|$ increases) or when the ex post difference in profits increases (that is, Δ increases). The empirical results in Rajan et al. (2000) are consistent with our theoretical predictions if the main reason why divisions are different is that some divisions are consistently better than other, that is the expected return from investment in some divisions is higher than others. In other words, if diversity stems from a difference in the p_i's across divisions then our model predicts that conglomerates with higher diversity will trade at a discount (remember that the advantage of the ICM form is maximal at $p=\frac{1}{2}$, that is when diversity is zero). On the other hand, for a fixed value $|p - \frac{1}{2}| \neq 0$ diversity may also increase because Δ increases. If the main reason why firms have different values of diversity is that their Δ's are different, then the predictions of our model are not consistent with the empirical findings in Rajan et al. (2000), since we predict that higher values of Δ increase the advantage of the ICM form.

4. Monetary incentives

We now show that the basic model is robust to the presence of monetary incentives for division managers. The managers' utility function now becomes

$$U(e_i, K_i, \tilde{R}_i, w_i) = w_i + \phi K_i \tilde{R}_i - k\,\frac{e_i^2}{2},$$

where w_i is the wage paid to the manager of division i. Headquarters maximizes total returns net of the wages paid to division managers. We assume that managers are protected by limited liability, i.e. $w_i \geqslant 0$, and analyze how wages should be optimally set in the stand-alone case and in the internal capital market case.

We begin our analysis with the stand alone case. Given the limited liability constraint and the risk-neutral framework, the optimal wage contract will pay zero to the manager when $C_i = 0$ and a positive amount when $C_i = 1$. Without ambiguity, let w_i denote the wage paid to the manager of division i when the first period cash flow of division i is 1.

In the stand-alone case, the problem of M_i is

$$\max_{e_i}\, [w_i + \phi(\underline{R} + p_i \Delta)] e_i - k\,\frac{e_i^2}{2}.$$

The necessary and sufficient condition for a maximum is

$$e_i = \frac{w_i + \phi(\underline{R} + p_i \Delta)}{k}.$$

We denote by $e_i^{\mathrm{SA}}(w_i)$ the solution to this equation, and observe that $\partial e_i^{\mathrm{SA}} / \partial w_i = 1/k$. The sum of the expected profit for the two divisions under the stand alone solution is now [12]

$$\Pi^{\mathrm{SA}} = (\underline{R} + p\Delta - w_1) e_1^{\mathrm{SA}}(w_1) + (\underline{R} + (1-p)\Delta - w_2) e_2^{\mathrm{SA}}(w_2).$$

[12] We assume that wages are paid at the end of the second period, so that all the cash flow produced at the end of period 1 is reinvested. Since we assume that the interest rate is 0 managers bear no cost for the delay in the payment.

The optimal wage for each division is given by the condition

$$-e_i^{\mathrm{SA}}(w_i) + (\underline{R} + p_i\Delta - w_i)\frac{\partial e_i^{\mathrm{SA}}}{\partial w_i} = 0$$

and using the expression obtained for $e_i^{\mathrm{SA}}(w_i)$ and $\partial e_i^{\mathrm{SA}}/\partial w_i$ we have

$$w_i^{\mathrm{SA}} = \frac{1-\phi}{2}(\underline{R} + p_i\Delta)$$

where $w_i^{\mathrm{SA}} > 0$ since $\phi < 1$. Note that in the stand-alone case the manager of the most profitable division (i.e. the one with higher p_i) is given a more high-powered incentive scheme, since the cash produced by the assets in place is more valuable. Substituting the optimal wage in the expression for $e_i^{\mathrm{SA}}(w_i)$ we have

$$e_i^{\mathrm{SA}} = \frac{1+\phi}{2k}(\underline{R} + p_i\Delta). \tag{4}$$

(Notice that Assumption 1 and $\phi < 1$ imply $e_i^{\mathrm{SA}} < 1$.) Finally, substituting in the expression for total profits we have

$$\Pi^{\mathrm{SA}} = \frac{(1+\phi)^2}{4k}[(\underline{R} + p\Delta)^2 + (\underline{R} + (1-p)\Delta)^2].$$

We turn now to the analysis of the ICM case. We first observe that since the problem is to provide incentives to exert effort and since the cash flow produced only depends on the manager's effort, in the optimal contract the wage is conditioned only to the amount of cash C_i generated in the division. A natural objection to this argument is that since the manager's private benefits also depend on the decision to reallocate funds across divisions, the wage contract should also depend on the reallocation decision. The following Lemma establishes that this is not the case.

Lemma 1. *The optimal incentive scheme in which manager's compensation is conditional on cash production and reallocation of funds is equivalent to the optimal incentive scheme where compensation is conditional only on cash production.*

This result is not at all surprising since it is a simple application of the sufficient statistics principle, due to Shavell (1979) and Holmström (1979). The Holmström–Shavell result states the following. Assume that s is a sufficient statistics for the agent's effort. Then the optimal incentive scheme should only be based on s. In other words, it is never optimal to condition the contract on variables different from s. In our setting, the cash flow produced by division i is a sufficient statistics for the effort of manager i. Therefore the principal (the Headquarters) can never do better by conditioning the contract (the wage paid to the managers) on other variables (e.g. redistribution of funds) different from the sufficient statistics, the cash flow.[13]

[13] Notice also that even in the case of a risk averse manager the space of contracts we allow would still remain entirely general, since the sufficient statistics result does not depend on risk neutrality or risk aversion. In fact, in the case of a risk averse agent, a contract based on variables different from the sufficient statistics is generally strictly inferior since it creates undesirable variance in the agent's payoff.

Lemma 1 shows that, when we look at managerial incentives, we can restrict attention without loss of generality to compensation schemes depending only on cash production. However, there may be a different reason to condition managers' compensation on the reallocation of funds, having to do with headquarters' incentives. Simply put, making managerial wages contingent on reallocation of funds may be a way in which headquarters commit not to reallocate the funds. In other words, the headquarters, anticipating that managerial incentives are blunted by the possibility of reallocating funds away from the division they manage, may solve this problem by setting the wage payment conditional on the reallocation of funds at such a high level that it is never optimal to reallocate any funds, effectively replicating the stand alone case. Headquarters would find it optimal to use such a wage scheme whenever the negative effect of reduced managerial incentives results in a discount.

We rule out this case from our analysis. First, it is unclear why the wage payment should be used as a commitment device. Other more effective instruments may serve such a purpose. For instance, headquarters may not acquire all the relevant information needed to decide when it is optimal to reallocate funds (Aghion and Tirole, 1997). Or they may spin off one division thereby granting to its manager authority of the division's cash flow. Second, these wage contracts may not be renegotiation-proof. Ex post, if the extra-profit generated by the reallocation of funds is higher than the loss of private benefits for the divisional manager, the headquarters has an incentive to approach the manager and renegotiate. Absent asymmetric information or other frictions, an agreement will be reached and funds will be reallocated. With such a scheme the manager has de facto a veto power over the reallocation decision. Granting such a veto power over the reallocation of funds may be optimal when the headquarters anticipates that the negative effect on incentives dominates the gains from redistributions of funds. In practice, however, it is very difficult to assess ex ante whether this case or its opposite will occur. Allowing divisional managers to veto the redistribution of funds may be too costly from an ex ante point of view.

We can now go back to computing the value of the firm. As before, with probability $1 - p_i$ division i has zero funds and with probability p_i receives the total expected amount of funds $e_1 + e_2$. The problem for M_i is therefore

$$\max_{e_i} \phi p_i(\underline{R} + \Delta)(e_i + e_{-i}) + e_i w_i - k\,\frac{e_i^2}{2}$$

and the necessary and sufficient condition for a maximum is

$$e_i = \frac{w_i + \phi p_i(\underline{R} + \Delta)}{k}.$$

Let us call $e_i^{\mathrm{ICM}}(w_i)$ the solution to this equation. The expected profit for headquarters is given by

$$\Pi^{\mathrm{ICM}} = (\underline{R} + \Delta)(e_i^{\mathrm{ICM}}(w_1) + e_2^{\mathrm{ICM}}(w_2)) - e_1^{\mathrm{ICM}}(w_1) \cdot w_1 - e_2^{\mathrm{ICM}}(w_2) \cdot w_2.$$

The optimal wage for each division is given by

$$-e_i^{\mathrm{ICM}}(w_i) + (\underline{R} + \Delta - w_i)\frac{\partial e_i^{\mathrm{ICM}}(w_i)}{\partial w_i} = 0$$

and using the expression for $e_i^{\mathrm{ICM}}(w_i)$ we have

$$w_i^{\mathrm{ICM}} = \frac{(1-\phi p_i)}{2}(\underline{R}+\Delta). \tag{5}$$

Note that in an internal capital market monetary incentives are more high powered for the *less* profitable division (i.e. the one with lower p_i). The intuition is the following: from the headquarters viewpoint the marginal return of a unit of cash is $\underline{R}+\Delta$, independently of the division that produces the cash flow. On the other hand, abstracting from monetary incentives, the less profitable division would exert a lower effort. To compensate for the reduced incentives, a higher wage is paid to the manager of division 2.

Another interesting comparison is between the wage paid in the stand-alone case and the ICM case. We have

Lemma 2. *The optimal wage paid to division managers is always more high-powered in an internal capital market than in the stand-alone case, that is* $w_i^{\mathrm{ICM}} \geqslant w_i^{\mathrm{SA}}$.

The intuition is the following: In the ICM case division managers have reduced non-monetary incentives with respect to the SA case, so that it is necessary to provide stronger monetary incentives in order to achieve the same level of effort. Moreover, the marginal value of effort is higher when an internal capital market is active, because of the possibility of winner-picking. Both arguments lead to the conclusion that wages are higher in the ICM case.

We can now compare managers' effort in the SA case and in the ICM case. A priori the result is not obvious. On one hand, the SA form provides stronger non-monetary incentives for effort. On the other hand, Lemma 2 shows that monetary incentives are stronger in the ICM case. The answer is provided in the following:

Lemma 3. $e_i^{\mathrm{ICM}} \geqslant e_i^{\mathrm{SA}}$ *if and only if* $\Delta \geqslant \phi\underline{R}$.

When the value created by winner-picking is high (Δ is high) headquarters offers division managers a high-powered compensation scheme that induces a high level of effort. Also, when private benefits are small (ϕ small) managerial incentives derive mostly from monetary compensation, which is higher in the ICM case.

The most important issue is the relative value of the stand-alone case *vis-à-vis* the internal capital market. Substituting $e_i = (w_i + \phi p_i(\underline{R}+\Delta))/k$ in the profit function we have

$$\Pi^{\mathrm{ICM}} = \frac{1}{4k}[(1+\phi p)^2 + (1+\phi(1-p))^2](\underline{R}+\Delta)^2.$$

Comparing this expression with Π^{SA} we have the following:

Proposition 2. (*a*) *There is a value* Δ^* *such that* $\Pi^{\mathrm{ICM}} \geqslant \Pi^{\mathrm{SA}}$ *if and only if* $\Delta > \Delta^*$. (*b*) *The difference* $\Pi^{\mathrm{ICM}} - \Pi^{\mathrm{SA}}$ *increases in* p *over the range* $(0, \frac{1}{2})$ *and decreases in* p *over the range* $(\frac{1}{2}, 1)$ *if* $\Delta > \phi\underline{R}$, *and vice versa if* $\Delta < \phi\underline{R}$.

Only when the expected value of winner-picking is sufficiently high an internal capital market is superior to the stand-alone case. Otherwise the adverse affect on incentives of the reallocation of corporate resources is the dominant effect and the value of the conglomerate is less than the sum of the stand-alone values of the two divisions. Therefore, the basic result of the previous section still holds: The ICM form is superior when Δ is large, and the SA form is superior when Δ is small.

When we look at the impact of asymmetry on the comparative advantage of the ICM form, the results are qualitatively the same as in the case of no monetary incentives when $\Delta > \phi\underline{R}$, that is an increase in asymmetry decreases the advantage of the ICM form. However, the opposite is true when $\Delta < \phi\underline{R}$.

To understand better why it is so, first notice that in the ICM case we have

$$e_1^{\mathrm{ICM}} + e_2^{\mathrm{ICM}} = \frac{1}{k}\left(1 + \frac{1}{2}\phi\right)(R + \Delta)$$

which is independent of p. Therefore, $(R + \Delta)(e_1^{\mathrm{ICM}} + e_2^{\mathrm{ICM}})$ is constant with respect to p in the ICM case, and any variation must come from the expected salary payment, $e_1^{\mathrm{ICM}} w_1^{\mathrm{ICM}} + e_2^{\mathrm{ICM}} w_2^{\mathrm{ICM}}$. To fix ideas, consider the case where $p > \frac{1}{2}$. When p increases, the expected wage bill decreases. The reason is that an increase in p increases non-monetary incentives in division 1, and decreases non-monetary incentives in division 2. The optimal response by headquarters is to decrease w_1^{ICM} and increase w_2^{ICM}, maintaining the sum $w_1^{\mathrm{ICM}} + w_2^{\mathrm{ICM}}$ constant. As a consequence of the changes in non-monetary and monetary incentives, e_1^{ICM} increases and e_2^{ICM} decreases, while the sum $e_1^{\mathrm{ICM}} + e_2^{\mathrm{ICM}}$ remains constant. This in turn implies that the low salary w_1^{ICM} is paid more often, and the high salary w_2^{ICM} is paid less often. The expected payment $e_1^{\mathrm{ICM}} w_1^{\mathrm{ICM}} + e_2^{\mathrm{ICM}} w_2^{\mathrm{ICM}}$ therefore decreases. Since $(\underline{R} + \Delta)(e_1^{\mathrm{ICM}} + e_2^{\mathrm{ICM}})$ remains constant, Π^{ICM} increases. In fact we have

$$\frac{\partial \Pi^{\mathrm{ICM}}}{\partial p} = \frac{1}{2k}(\underline{R} + \Delta)^2 \phi^2 (2p - 1).$$

Consider now the SA case. We know that, differently from w_i^{ICM}, an increase in p_i increases w_i^{SA}. Since e_i^{SA} is also increasing in p_i, an opposite effect respect to the ICM case is at work: now the higher salary is paid more often, so that the total wage bill increases. However, we also have a positive effect, since cash ends up more frequently in the division with the higher return. The sum of the two effects must be positive, since headquarters would not optimally choose to pay a higher expected salary if this did not produce a higher profit. In fact we have

$$\frac{\partial \Pi^{\mathrm{SA}}}{\partial p} = \frac{1}{2k}(1 + \phi)^2 \Delta^2 (2p - 1).$$

Let us now compare the two derivatives. Consider first the extreme case in which $\phi = 0$, so that the condition $\Delta > \phi\underline{R}$ is always satisfied. In this case the ICM form is insensitive to p. The only incentives are monetary, and funds are always allocated to their best use. Furthermore, if $\phi = 0$ effort and salary are the same in both divisions. Things are different for the SA form. Again, incentives are only monetary, but now headquarters optimally chooses a higher salary for the division with the higher p and a lower salary for the other division. The total quantity of effort remains constant, but now more effort is exerted in the high-return division. This increases the value of Π^{SA}, since it is now more likely that funds obtain a high return. Therefore, the comparative advantage of the SA form vs. the ICM increases when p increases. When ϕ is sufficiently small a similar effect is at work.

Consider next the other extreme case in which Δ is very close to 0, so that the condition $\Delta < \phi \underline{R}$ is always satisfied. In this case a change in p has basically no impact on Π^{SA}, since the optimal amounts of salary and effort remain the same in both divisions. At the same time, it remains true that Π^{ICM} increases because of the reduction in the wage bill. Therefore, in this case it is the ICM form that increases its comparative advantage when p increases.

5. Asymmetric divisions

We now investigate the impact of asymmetries in divisions' size on the conglomerate discount. More precisely, we are interested in the following question: Assume that division 1 is larger than division 2 in the sense that it produces, for a given effort, a higher expected cash flow. Does this asymmetry in size affect the conglomerate discount? And in which direction?

We are interested only in the effect of the relative scale of the two divisions. To disentangle differences in scale from differences in profitability we assume that effort has constant returns to scale in producing cash flows, that is we assume that all the revenues and costs (including the disutility of effort) of a division are multiplied by the same (positive) constant. In other words, we multiply by the same constant S_i both the amount of cash produced when effort is successful and the cost of effort. [14]

Moreover, since we are interested only in evaluating the impact of asymmetries among divisions, we keep the total scale of the conglomerate constant. Let $2S$ denote total scale of activity. Then the scale of division 1 is $S_1 = S(1+\gamma)$ and the scale of division 2 is $S_2 = S(1-\gamma)$, with $\gamma \in (-1, 1)$. When γ is positive then division 1 is larger than division 2 and vice-versa when γ is negative. The case $\gamma = 0$ corresponds to the case where the two divisions have the same size. Size and profitability need not be positively correlated. In particular, it is possible, for instance, that division 1 is larger than division 2 ($\gamma > 0$) and at the same time it has lower growth prospects ($p < 1/2$). We will say that in this situation division 1 is a cash cow and division 2 is a rising star. We will show that the case where future profitability and current size are not aligned reduces total profits both in the case of stand alone divisions and of a conglomerate with internal capital markets, but that the effect is stronger in the latter case. More precisely, we show that it is more likely to observe a conglomerate discount when a cash cow and a rising star belong to the same conglomerate.

[14] Obviously a larger scale can be associated to either a reduction or an increase in the cost of effort. But since we are interested only in capturing the effect of scale, we do not want to consider those effects. The same modeling choice is made in Holmström and Tirole (1997), when they go from the analysis of a fixed size investment project to a variable size investment project.

As usual, consider first the stand-alone case. The problem of M_1 at time zero is

$$\max_{e_1} S(1+\gamma)\left[\phi(\underline{R}+p\Delta)e_1 - k\,\frac{e_1^2}{2}\right].$$

The optimal level of effort is the same we have found in Section 3,[15] that is

$$e_1^{\mathrm{SA}} = \frac{\phi(\underline{R}+p\Delta)}{k}.$$

Similarly, for division 2 we have

$$e_2^{\mathrm{SA}} = \frac{\phi(\underline{R}+(1-p)\Delta)}{k}.$$

When the divisions operate as stand-alones, the expected cash flow is

$$\begin{aligned} C^{\mathrm{SA}} &= \frac{\phi(\underline{R}+p\Delta)}{k}\,S(1+\gamma) + \frac{\phi(\underline{R}+(1-p)\Delta)}{k}\,S(1-\gamma) \\ &= \frac{\phi S}{k}[2\underline{R} + \Delta(\gamma(2p-1)+1)]. \end{aligned} \tag{6}$$

Asymmetry increases when $|\gamma|$ increases. It is clear from (6) that expected cash flow is increasing in $|\gamma|$ when size and profitability are aligned (that is, $\gamma > 0$ and $p > \frac{1}{2}$ or $\gamma < 0$ and $p < \frac{1}{2}$). Otherwise, an increase in asymmetry decreases the cash flow. The intuition is the following. Consider the case $p < \frac{1}{2}$ to fix ideas. Then the manager of division 1 has a lower probability of being financed in the second period and thus he exerts a lower effort than the manager of division 2. If division 1 is larger than division 2 ($\gamma > 0$) then the total cash flow produced decreases, whilst the opposite occurs when division 1 is smaller than division 2 ($\gamma < 0$).

The sum of the expected profit for the two divisions under the stand-alone solution is given by

$$\begin{aligned} \Pi^{\mathrm{SA}} &= (\underline{R}+p\Delta)S(1+\gamma)e_1^{\mathrm{SA}} + (\underline{R}+(1-p)\Delta)S(1-\gamma)e_2^{\mathrm{SA}} \\ &= \frac{\phi S}{k}((1+\gamma)(\underline{R}+p\Delta)^2 + (1-\gamma)(\underline{R}+(1-p)\Delta)^2). \end{aligned}$$

The impact of a change in the size of division 1 on total profits is given by

$$\frac{\partial \Pi^{\mathrm{SA}}}{\partial \gamma} = \frac{\phi}{k}\,S((\underline{R}+p\Delta)^2 - (\underline{R}+(1-p)\Delta)^2) = \frac{\phi}{k}(2p-1)(2\underline{R}+\Delta)\Delta S.$$

If $p < \frac{1}{2}$ then $\mathrm{d}\Pi^{\mathrm{SA}}/\mathrm{d}\gamma < 0$. To understand the result, consider the case $\gamma > 0$, so that an increase in γ directly correspond to an increase in asymmetry. As we have shown, an increase in γ reduces the total cash flow produced (and reinvested) when $p < \frac{1}{2}$. Furthermore, an increase in γ implies that more cash flow will be reinvested in division 1, which is less profitable than division 2.

[15] In our formulation a change in the scale of operations does not change the marginal productivity and the marginal cost of effort, so that scale has no impact on the effort chosen by the division manager. This allows us to separate the effects of a change in the relative scale of the two divisions from the effects of a change in the relative profitability of effort.

Consider now the ICM case. Division 1 faces a probability $1-p$ of having zero funds and a probability p of having all funds. Remember also that cash flow and disutility of effort are scaled by a factor $S(1+\gamma)$ for division 1 and $S(1-\gamma)$ for division 2. Therefore the optimal levels of effort will be the same found in Section 3, i.e.

$$e_1^{\mathrm{ICM}} = \frac{\phi}{k} p(\underline{R} + \Delta)$$

and

$$e_2^{\mathrm{ICM}} = \frac{\phi}{k}(1-p)(\underline{R} + \Delta).$$

The expected cash flow generated is

$$\begin{aligned} C^{\mathrm{ICM}} &= S(1+\gamma)\frac{\phi}{k} p(\underline{R}+\Delta) + S(1-\gamma)\frac{\phi}{k}(1-p)(\underline{R}+\Delta) \\ &= \frac{S(\underline{R}+\Delta)\phi}{k}[1+\gamma(2p-1)]. \end{aligned}$$

In the case of ICM we still have that a misalignment of size and profitability implies a negative relation between asymmetry and expected cash flow. Notice however that, when we consider the case $\gamma > 0$ and $p < \frac{1}{2}$, we have

$$\frac{\partial C^{\mathrm{ICM}}}{\partial \gamma} = \frac{S(\underline{R}+\Delta)\phi}{k}(2p-1) < \frac{\phi S}{k}\Delta(2p-1) = \frac{\partial C^{\mathrm{SA}}}{\partial \gamma},$$

so that the negative impact of increased asymmetry is stronger in the ICM case than in the SA case (the same holds when $\gamma < 0$ and $p > \frac{1}{2}$).

The expected profit for headquarters in the ICM case is given by

$$\begin{aligned} \Pi^{\mathrm{ICM}} &= (\underline{R}+\Delta)(e_1^{\mathrm{ICM}} S(1+\gamma) + e_2^{\mathrm{ICM}} S(1-\gamma)) \\ &= \frac{\phi S}{k}(\underline{R}+\Delta)^2(1+(2p-1)\gamma). \end{aligned}$$

The impact of an increase in the relative size of division 1 on total profits is given by

$$\frac{\mathrm{d}\Pi^{\mathrm{ICM}}}{\mathrm{d}\gamma} = \frac{\phi}{k}(2p-1)(\underline{R}+\Delta)^2 S$$

and therefore when $p < \frac{1}{2}$ it follows that $\mathrm{d}\Pi^{\mathrm{ICM}}/\mathrm{d}\gamma < 0$. The intuition is the following: when $p < \frac{1}{2}$ the effort of division 1 is lower than the effort of division 2 because the manager of division 1 anticipates that she has a smaller probability of being financed in the second period. As the size of division 1 increases the total expected cash flow to be reinvested in the second period decreases and so does total profit. In this sense, as division 1 becomes a cash cow (γ increases) keeping p constant (and less than $\frac{1}{2}$) total profit in the conglomerate decreases.

We can finally address the question of the impact of differences in the divisions' size on the conglomerate discount. Simple calculations show that [16]

$$\Pi^{\mathrm{ICM}} - \Pi^{\mathrm{SA}} = \frac{\phi}{k} S[2p(1-p)\Delta^2 + \underline{R}^2(2p-1)\gamma - \underline{R}^2].$$

We have the following result.

Proposition 3. *The difference $\Pi^{\mathrm{ICM}} - \Pi^{\mathrm{SA}}$ is decreasing in $|\gamma|$ if $\gamma(p-\frac{1}{2}) < 0$, and increasing if $\gamma(p-\frac{1}{2}) > 0$.*

The proposition states that an increased asymmetry increases the difference $\Pi^{\mathrm{ICM}} - \Pi^{\mathrm{SA}}$ when size and profitability are aligned (this is the case $\gamma(p-\frac{1}{2}) > 0$), and it decreases it otherwise. The result implies that the ICM form is more likely to be disadvantageous when a "cash cow" and a "rising star" are put together. Other things equal, we should therefore observe on average a higher conglomerate discount when divisions are asymmetric in current profitability and growth prospects, with the divisions having more cash also being the ones with poorer growth prospects.

The result appears counter-intuitive, since the advantage of internal capital markets should be at its maximum when a division with high potential but no cash can use the funds generated in divisions with no potential. Remember however that here the total amount of funds available for investment is endogenous, and combining a "cash cow" and a "rising star" seriously diminishes the incentives for funds generation in the cash cow.

To have a better intuition for the result it is useful to decompose the difference in profits between the ICM case and the SA case as

$$\begin{aligned}\Pi^{\mathrm{ICM}} - \Pi^{\mathrm{SA}} = {} & \Delta S[(1-p)e_1^{\mathrm{ICM}}(1+\gamma) + pe_2^{\mathrm{ICM}}(1-\gamma)] \\ & - [(\underline{R} + p\Delta)S(1+\gamma)(e_1^{\mathrm{SA}} - e_1^{\mathrm{ICM}}) \\ & + (\underline{R} + (1-p)\Delta)S(1-\gamma)(e_2^{\mathrm{SA}} - e_2^{\mathrm{ICM}})].\end{aligned}$$

The first term is the "winner-picking" effect, while the term inside the square brackets captures the effect of the reduced effort in an internal capital market on each division's profit. The first term can be written as

$$2\Delta S \frac{\phi}{k}(\underline{R} + \Delta)p(1-p)$$

which does not depend on γ. Asymmetries in divisions' size do not have an impact on the value created by winner-picking. Although the divisions' asymmetry has an impact on the total cash flow produced, it has no effect on the total cash flow that is reallocated to the best project opportunity in an internal capital market.

[16] Not surprisingly, this formula boils down to the equivalent formula found in Section 3 when $S = 1$ and $\gamma = 0$.

We are left only with the second term. Differentiating with respect to γ we obtain

$$-S\,\frac{\phi}{k}\,\underline{R}[(1-p)(\underline{R}+p\Delta)-p(\underline{R}+(1-p)\Delta)] = S\,\frac{\phi}{k}\,\underline{R}^2(2p-1)$$

which is negative for $p<\frac{1}{2}$. The intuition is the following. When $p<\frac{1}{2}$ division 1 is less profitable than division 2 and moreover the reduction in effort due to the reallocation of resources in an internal capital market is stronger in division 1 ($e_1^{\mathrm{SA}}-e_1^{\mathrm{ICM}}=\frac{\phi}{k}(1-p)\underline{R}>\frac{\phi}{k}p\underline{R}=e_2^{\mathrm{SA}}-e_2^{\mathrm{ICM}}$). As the size of division 1 increases the magnitude of these two negative effects is boosted and a conglomerate discount becomes more likely.

6. Conclusions

This paper has argued that one of the distinctive features of internal capital markets, that is the ability of headquarters to reallocate funds across divisions (winner-picking) is associated both with costs and benefits. The benefits derive from transferring funds to the most profitable divisions; the costs derive from the weakening of managerial incentives. In other words, winner-picking is simultaneously the dark and the bright side of internal capital markets. Our theory can explain why conglomerate firms trade at a discount (or at a premium) with respect to their focused counterparts. More importantly, it does so without assuming any inefficiency in the allocation of corporate resources. We show that ex ante diversity in divisions' profitability increases the inefficiency of an internal capital market, and that mismatches between divisions' size and profitability also reduce the value of internal capital markets.

An important *caveat* is that we have not addressed the reasons why divisions that are very different in terms of their profitability are brought together in the same firm and why some divisions are not spun-off in those circumstances where conglomerates are inefficient. Moreover, we have assumed that all resources are internally generated, ignoring the role of external financing. These limitations notwithstanding, we believe that the analysis of internal capital markets in terms of allocation of delegation of authority may be a promising direction for future research.

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Appendix A

Proof of Proposition 1. Using the expression for $\Pi^{\mathrm{ICM}} - \Pi^{\mathrm{SA}}$ given by (3) and the expressions for $e_i^{\mathrm{SA}}, e_i^{\mathrm{ICM}}$ given by (1) and (2) we obtain

$$\Pi^{\mathrm{ICM}} - \Pi^{\mathrm{SA}} = \frac{\phi}{k}(\underline{R} + \Delta)^2 - \frac{\phi}{k}\left[(\underline{R} + p\Delta)^2 + (\underline{R} + (1-p)\Delta)^2\right]$$

$$= \frac{\phi}{k}[2p(1-p)\Delta^2 - \underline{R}^2].$$

This is a strictly increasing function of Δ and a strictly decreasing function of $\underline{R}$. For a given pair $\underline{R}, \Delta$ the function reaches a maximum at $p = \frac{1}{2}$ and is decreasing in p for $p > \frac{1}{2}$. □

Proof of Lemma 1. Consider an incentive scheme where the wage is made contingent on whether cash is produced or not in the division *and* on whether the cash produced is reallocated away or stays in the division. [17] There are three possible cases.

1. The cash flow produced by manager i is 0; in this case funds cannot be reallocated away. Let $w_i(0)$ be the wage paid in this case to manager i.
2. The cash flow produced by manager i is 1 and funds are not reallocated away (NRA) from division i. Let $w_i(1, NRA)$ be the wage paid in this case to manager i.
3. The cash flow produced by manager i is 1 and funds are reallocated away (RA). Let $w_i(1, RA)$ be the wage paid in this case to manager i.

The problem of manager i is to maximize with respect to e_i (for notation simplicity we suppress the index ICM) the objective function

$$U_i = p_i\phi(\underline{R} + \Delta)(e_i + e_{-i}) + (1 - e_i)w_i(0)$$

$$+ e_i[p_i w_i(1, NRA) + (1 - p_i)w_i(1, RA)] - k\frac{e_i^2}{2}.$$

The first term represents the expected private benefits that manager i receives when he obtains all the funds because his division has the best project at time $t = 2$. The remaining terms are the expected wage.

The FOC yields

$$e_i = \frac{1}{k}(p_i\phi(\underline{R} + \Delta) + p_i w_i(1, NRA) + (1 - p_i)w_i(1, RA) - w_i(0)).$$

The Headquarters objective is to maximize with respect to the wage schedules of the two managers the following function:

$$\Pi^{\mathrm{ICM}} = (\underline{R}+\Delta)(e_1+e_2) - e_1(pw_1(1, NRA)+(1-p)w_1(1, RA)) - (1 - e_1)w_1(0)$$

$$-e_2((1-p)w_2(1, NRA) + pw_2(1, RA)) - (1 - e_2)w_2(0).$$

[17] In principle the wage can also depend on cash production and reallocation in the *other* division. It is clear however that there is no point in making the wage of the divisional manager conditional on such events, since they have no impact on the effort decision.

Observe first that $w_i(0)$ has a negative impact both on the manager incentive problem and on the Headquarters profit. Thus, they must be set at the lowest possible value which, by the assumption of limited liability, is given by 0.

Therefore the FOC can be written as

$$e_i = \frac{1}{k}[p_i\phi(\underline{R}+\Delta) + p_i w_i(1,NRA) + (1-p_i)w_i(1,RA)]$$

and the Headquarters objective function becomes

$$\Pi^{\mathrm{ICM}} = (\underline{R}+\Delta)(e_1+e_2) - pe_1w_1(1,NR) - (1-p)e_1w_1(1,R)$$
$$-(1-p)e_2w_2(1,NRA) - pe_2w_2(1,RA).$$

Substituting the expression for e_i given by the FOC into the objective function, we can solve for the optimal wage contract.

The FOC with respect to $w_1(1,NRA)$ and to $w_1(1,RA)$ yield, respectively,

$$(1-\phi p)(\underline{R}+\Delta) = 2[pw_1(1,NRA) + (1-p)w_1(1,RA)]$$

and

$$(1-\phi p)(\underline{R}+\Delta) = 2[pw_1(1,NRA) + (1-p)w_1(1,RA)].$$

Notice that the two FOCs yield the same expression.

This is a consequence of the fact that both e_i and Π^{ICM} only depend on the expected value of the wage paid in case of success. But this implies that conditioning on redistribution is irrelevant. All that matters is the expected wage w_i paid when cash production is 1. This completes the proof. □

To have a clearer understanding of the lemma it is useful to define $w_1 \equiv pw_1(1,NRA) + (1-p)w_1(1,RA)$. Then we obtain

$$w_1 = \frac{(1-\phi p)(\underline{R}+\Delta)}{2}$$

which is the expression for the optimal wage when we only condition on cash production (see Eq. (5)).

Similarly, if we repeat the same process for $w_2(1,NRA)$ and $w_2(1,RA)$ and we define $w_2 \equiv (1-p)w_2(1,NRA) + pw_2(1,RA)$ we obtain

$$w_2 = \frac{(1-\phi(1-p))(\underline{R}+\Delta)}{2},$$

which is again the expression obtained in Eq. (5).

Proof of Lemma 2. The condition $w_i^{\mathrm{ICM}} > w_i^{\mathrm{SA}}$ is equivalent to

$$\frac{1-\phi p_i}{2}(\underline{R}+\Delta) > \frac{1-\phi}{2}(\underline{R}+p_i\Delta)$$

or, after simplifications,

$$(\Delta + \phi\underline{R})(1-p_i) \geqslant 0$$

which is always satisfied. □

Proof of Lemma 3. Substituting for the expressions found for the optimal wage, we have:

$$e_i^{\mathrm{ICM}} = \frac{(1+\phi p_i)(\underline{R}+\varDelta)}{2k}.$$

Comparing it with expression of e_i^{SA} given by (4) yields the result. □

Proof of Proposition 2. Define the ratio

$$\frac{\varPi^{\mathrm{ICM}}(\varDelta,p)}{\varPi^{\mathrm{SA}}(\varDelta,p)} = \frac{((\underline{R}+\varDelta)(1+\phi p)/2)^2 + ((\underline{R}+\varDelta)(1+\phi(1-p))/2)^2}{((1+\phi)(\underline{R}+p\varDelta)/2)^2 + ((1+\phi)(\underline{R}+(1-p)\varDelta)/2)^2}.$$

Consider point (a). Direct computation shows that, for each p:

$$\frac{\varPi^{\mathrm{ICM}}(0,p)}{\varPi^{\mathrm{SA}}(0,p)} < 1, \qquad \lim_{\varDelta\to+\infty} \frac{\varPi^{\mathrm{ICM}}(\varDelta,p)}{\varPi^{\mathrm{SA}}(\varDelta,p)} > 1$$

and

$$\frac{\partial(\varPi^{\mathrm{ICM}}(\varDelta,p)/\varPi^{\mathrm{SA}}(\varDelta,p))}{\partial\varDelta} > 0$$

thus establishing the result.

Next, consider point (b). Using the expressions for $\varPi^{\mathrm{ICM}}$ and $\varPi^{\mathrm{SA}}$ given in the text we have

$$\frac{\partial(\varPi^{\mathrm{ICM}} - \varPi^{\mathrm{SA}})}{\partial p} = \frac{(\varDelta + 2\Delta\phi + \phi R)(\phi R - \varDelta)(2p-1)}{2k}.$$

If $p > \frac{1}{2}$ then the sign of the derivative is equal to the sign of $(\phi R - \varDelta)$, thus establishing the result. □

Proof of Proposition 3. Suppose first $\gamma > 0$, so that an increase in γ corresponds to an increase in asymmetry. By direct computation we have

$$\frac{\mathrm{d}(\varPi^{\mathrm{ICM}} - \varPi^{\mathrm{SA}})}{\mathrm{d}\gamma} = (2p-1)\frac{\phi}{k}\underline{R}^2 S$$

so that the difference $\varPi^{\mathrm{ICM}} - \varPi^{\mathrm{SA}}$ decreases in γ when $p < \frac{1}{2}$ and increases otherwise.

If $\gamma < 0$ then an increase in asymmetry corresponds to a decrease in γ, so that the impact of an increase in asymmetry has the opposite sign of the derivative. In this case an increase in asymmetry increases the difference $\varPi^{\mathrm{ICM}} - \varPi^{\mathrm{SA}}$ if $p < \frac{1}{2}$, and decreases it otherwise. □

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