Internal vs. External Financing: An Optimal Contracting Approach*

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Abstract

This paper compares optimal financial contracts with centralized and decentralized firms. Under centralized contracting headquarters raises funds on behalf of multiple projects and then allocates the funds on the firm's internal capital market. Under decentralized contracting each project raises funds separately on the external capital market. The benefit of centralization is that headquarters can use excess liquidity from high-cash flow projects to buy continuation rights for low cash-flow projects. This allows headquarters to make greater repayments to investors, which eases financing constraints ex ante. The cost is that headquarters may pool cash flows from several projects, thereby accumulate internal funds, and make follow-up investments without having to return to the capital market. Absent any capital market discipline, however, it is more difficult for investors to force headquarters to pay out funds, which tightens ex-ante financing constraints.

Keywords: Financial contracting; internal capital markets; theory of the firm.

JEL Classification Numbers: D32; G31; G32; G34.

1 Introduction

Beginning with Fazarri, Hubbard, and Petersen (1988), several papers have documented that the investment behavior of firms is affected by financing constraints.[1] While it is commonly argued that financing constraints are caused by market imperfections such as moral hazard or asymmetric information, little is known about the extent to which firms can actively mitigate financing constraints through their organizational structure. In this paper we examine whether financial contracts with centralized firms where headquarters raises funds on behalf of multiple projects are more efficient than contracts with stand-alone firms, and how this translates into the firm's financing constraint.

Hints on the role which centralization may play for financing constraints are found in the internal capital markets literature. There, headquarters either creates or destroys value inside the firm, e.g., by engaging in winner-picking (Stein 1997), by redeploying assets (Gertner, Scharfstein, and Stein 1994), or by affecting project managers' incentives (Stein 2000). Naturally, this value creation or destruction will affect the return to capital and hence also the firm's financing constraint. As none of these papers adopts an optimal contracting approach, the precise nature and magnitude of the effect remains unclear, however.[2] On the other hand, financial contracting models, while deriving financing constraints and the associated underinvestment problem from first principles, typically consider an entrepreneurial firm where the entrepreneur raises funds for a single project. In this setting, questions of organizational structure cannot be addressed.

This paper connects the internal capital markets literature with that on optimal financial contracting, thus tying together in- and external capital markets. We compare financial contracting between i) outside investors and individual project managers ("decentralized borrowing") and ii) outside investors and headquarters, which borrows on behalf of multiple projects and subsequently allocates the funds on the firm's internal capital market ("centralized borrowing"). Financing constraints arise endogenously from the assumption that part of the project cash flow is nonverifiable. The crux is to provide the firm (i.e., the project manager or headquarters) with incentives to pay out funds rather than to divert them. To distinguish our model from others we assume that headquarters

[1] See Hubbard (1998) for an overview of the literature.

[2] Stein (1997) rules out optimal contracting by assuming that it is too costly to elicit managers' private information. Scharfstein and Stein (2000) assume that outside investors can only decide on the size of their investment and the firm's operating budget. In particular, contracts contingent on (reported) cash flows are not considered. Finally, Gertner, Scharfstein, and Stein (1994) consider optimal contracts, but not between headquarters and outside investors. More precisely, the authors compare contracting between project managers and investors under two scenarios: i) the manager owns the project and ii) the investor owns the project. In the latter case they call the investor "headquarters". The possibility that headquarters itself may have to raise funds from outside investors is not explored.

creates or destroys no value as such. That is, there is no winner-picking, managerial effort, or misallocation of funds inside the firm.

The benefit of centralization is that financial contracts with centralized firms are more efficient. To make the firm reval its true cash flow, investors must offer it a bribe. Bribes can come either in the form of a lower repayment or a higher continuation benefit. Under centralized borrowing a greater fraction of the bribe comes in the form of continuation benefits, which is efficient as it involves undertaking positive NPV investments that would have not been undertaken otherwise. Effectively, headquarters uses excess liquidity from high cash-flow projects to buy continuation rights for low cash-flow projects. This allows headquarters to make greater repayments to investors, which eases financing constraints ex ante. The cost of centralization is that headquarters may pool cash flows from several projects, thereby accumulate internal funds, and make follow-up investments without having to return to the capital market. Absent any capital market discipline, it is more difficult for investors to force the firm to pay out funds, which tightens ex-ante financing constraints. This last point is reminiscent of Jensen (1986), where the problem is also that firms can invest without having to revisit the capital market. Our model adopts an ex-ante perspective: anticipating that a free cash-flow problem may arise in the future, investors are reluctant to provide financing in the first place.

Based on these costs and benefits, we trace out the boundaries of the firm. Holding everything else fixed, centralization is optimal for projects with a low expected return, or productivity, while decentralization is optimal for projects with a high expected return. Cross-sectionally, this implies that conglomerates should have a lower average productivity than stand-alone firms. Moreover, we provide testable implications linking financing constraints to operating productivity, the degree of firm diversification, and the composition of the firm's investment portfolio.

The rest of the paper is organized as follows. Section 2 derives the costs and benefits of centralization in an optimal contracting framework. Section 3 discusses robustness issues and related literature. Section 4 contains various extensions of the basic model. Section 5 summarizes the empirical implications and contrasts them with the evidence. Section 6 concludes. All proofs are in the Appendix.

2 Centralized vs. Decentralized Borrowing

The Model

The model is a multi-period contracting model with partially non-verifiable cash flows in the spirit of Bolton and Scharfstein (1990), DeMarzo and Fishman (2000), Gertner, Scharfstein, and Stein (1994), and Hart and Moore (1998). While the basic formulation here follows Bolton and Scharfstein, none of the results depend on the specifics of their model. In Section 3 we show that the same tradeoff also obtains in a Hart-Moore (1998) type framework.

Suppose a project lasts for two periods. In each period it requires an investment outlay $I > 0$ and yields an end-of-period cash flow $\pi_l < I$ with probability $p > 0$ and $\pi_h > I$ with probability $1 - p$, where $\pi_h > \pi_l$. Cash flows are uncorrelated across periods. Instead of assuming that a project lasts for two periods we could equally imagine two separate, but technologically identical (sub-)projects that are carried out one after the other. The expected per-period cash flow net of investment costs is strictly positive, i.e., $\overline{\pi} := p\pi_l + (1-p)\,\pi_h > I$.

Suppose a firm has two such two-period projects. For the moment we assume that cash flows are uncorrelated across projects. In Section 4 we relax this assumption. As the firm has no funds it must raise funds from outside investors. For convenience we assume there is a single investor who makes a take-it-or-leave-it offer to the firm. While the assumption that there is a single investor may seem unrealistic, it is inconsequential for our results. The only reason for making this assumption is that it simplifies the contracting problem. In Section 3 we discuss competitive credit markets.

The firm's founder can choose between two organizational structures, which differ in their assignment of projects to managers. Under *centralized borrowing* a single manager called *headquarters* is in charge of both projects. Under *decentralized borrowing* a separate *project manager* is in charge of each project. We use the standard assumption that agents in charge of projects maximize the cash proceeds from projects under their control, e.g., because they derive private benefits that are proportional to these proceeds. As projects require no monitoring or managerial effort, but only capital, the question is therefore whether the founder should form one firm where headquarters borrows on behalf of both projects or two separate firms that borrow independently on the external capital market. While the problem is framed as an organizational design problem, it could be equally framed as a divestiture problem where a conglomerate contemplates spinning off one of its divisions. The model and results are the same.

Neither cash flows nor investment decisions are verifiable, which implies contracts can only condition on payments to and from the investor as well as public messages.[3] The assumption that cash flows are nonverifiable is standard and captures the idea that firms have some leeway to conceal profits. The assumption that investment decisions are

[3] As we adopt a message-game approach it is irrelevant whether cash flows and investment decisions are observable but nonverifiable, or whether insiders (i.e., project managers or headquarters) can observe cash flows and investment decisions but outsiders cannot. We may therefore equally assume that cash flows and investment decisions are privately observable.

nonverifiable simplifies the analysis but is not needed. In Section 3 we show that the same tradeoff obtains in a setting where investment decisions are verifiable. Finally, even though courts cannot observe actual cash flows, it is commonly known that the lowest possible cash flow is π_l. Hence we may alternatively assume that a fraction π_l of the cash flow is verifiable and only the difference $\pi_h - \pi_l$ is nonverifiable.

Under both centralized and decentralized borrowing the partial nonverifiability of cash flows creates an incentive problem between the firm and the investor. Under centralized borrowing the problem is to provide headquarters with incentives to pay out funds (rather than to divert them). Under decentralized borrowing the problem is to provide individual project managers with incentives to pay out funds. With regard to centralized borrowing there are two subcases, depending on whether a high cash-flow firm can (partly) self-finance second-period investment or not. We label these subcases "self-financing" and "no self-financing", respectively.

Decentralized Borrowing

This is our benchmark. Under decentralized borrowing each of the two project managers borrows separately on the external capital market. As the contracting problem is the same for each manager, we henceforth speak of *the* manager and *the* project. The standard way to deal with nonverifiability of cash flows is to adopt a message-game approach. In the present context, this means that after the cash flow is realized, the manager makes a publicly verifiable announcement stating that the cash flow is either low or high. The sequence of events is as follows:

- Date 0: the investor pays I and the manager (optimally) invests.
- Date 1: the manager announces that the first-period cash flow is $\hat{s} \in \{l, h\}$. Based on this announcement, the manager makes a first repayment $R^1(\hat{s})$, and the investor finances second-period investment, i.e., he pays I a second time, with probability $\beta(\hat{s})$. If the manager receives I, he again (optimally) invests.
- Date 2: based on the date 1-announcement, the manager makes a second repayment $R^2(\hat{s})$.

Two comments are in order. Like most financial contracting models, we allow for probabilistic (re-)financing schemes to permit nontrivial solutions. If the continuation probability can be either zero or one the qualitative results are the same, but the benefits from centralization are smaller. Second, while it is theoretically possible to have the manager also announce the second-period cash flow (in case he receives funding at date 1), this is pointless as he will always claim that the second-period cash flow is low. By contrast, it is possible to induce the manager to truthfully reveal the first-period cash flow by threatening him not to provide second-period financing. An implicit assumption herein is that, if the manager of a high cash-flow firm claims that the cash flow is low, he cannot use the remaining cash to self-finance second-period investment. If he could, the investor's threat to terminate funding would be empty and financing would break down completely. Formally, the assumption is

(A.1) $\pi_h - \pi_l < I.$

Recall that the investor can always extract π_l. An immediate implication of (A.1) is that $\pi_l > 0$, or else the assumption that $\pi_h > I$ is violated. The optimal financial contract is then the solution to the following problem:

$$\max_{\beta(s),R^1(s),R^2(s)} -I + p\left[R^1(l) + \beta(l)\left(R^2(l) - I\right)\right] + (1-p)\left[R^1(h) + \beta(h)\left(R^2(h) - I\right)\right]$$

s.t.

$$r(s) - R^1(s) + \beta(s)\left[\overline{\pi} - R^2(s)\right] \geq r(s) - R^1(\hat{s}) + \beta(\hat{s})\left[\overline{\pi} - R^2(\hat{s})\right] \text{ for all } s, \hat{s} \in \{l, h\},$$

$$R^1(s) \leq r(s) \text{ for all } s \in \{l, h\}, \tag{1}$$

and

$$R^2(s) \leq r(s) - R^1(s) + \pi_l \text{ for all } s \in \{l, h\}, \tag{2}$$

where $r(l) := \pi_l$ and $r(h) := \pi_h$.

The first constraint is the manager's incentive compatibility (or truthtelling) constraint. The remaining two constraints are limited liability constraints. The first states that the first-period repayment must not exceed the first-period cash flow, while the second states that the total repayment must not exceed the sum of first- and second-period cash flows. Whenever (1)-(2) are satisfied, the manager's individual rationality constraint is also satisfied, which is why it can be omitted.

From Bolton and Scharfstein (1990) we know that the solution to this sort of problem is $\beta(l) = 0$, $\beta(h) = 1$, $R^1(l) = R^2(h) = \pi_l$, and $R^1(h) = \overline{\pi}$. If the manager announces that the first-period cash flow is high, he receives second-period financing for sure. If he announces that the cash flow is low, he receives no second-period financing.

The optimal contract involves two types of inefficiencies. First, with probability p the second-period investment is not undertaken. Despite this inefficiency, however, there will be no renegotiation on the equilibrium path as the maximum which the investor can assure in the second period is $\pi_l < I$. Second, if we insert the optimal contract in the investor's objective function and solve for the value of I at which he breaks even, we have that the investor invests at date 0 if and only if

$$I \leq \overline{\pi} - \frac{\overline{\pi} - \pi_l}{2-p}. \tag{3}$$

Projects that cost less than $\overline{\pi}$ but more than the right-hand side in (3) receive no funding at date 0 even though they have a strictly positive NPV. In other words, the firm is financially constrained.

Centralized Borrowing: No Self-Financing

Under centralized borrowing headquarters borrows against the combined cash flow of the two projects. The relevant cash flow is therefore $r(l,l) := 2\pi_l$ with probability p^2, $r(l,h) := \pi_l + \pi_h$ with probability $2p(1-p)$, and $r(h,h) := 2\pi_h$ with probability $(1-p)^2$. The sequence of events is the same as under decentralized borrowing.

As a contract now encompasses two projects, the contracting space becomes larger. In particular, the investor may use separate refinancing probabilities $\beta_1(\hat{s})$ and $\beta_2(\hat{s})$ for each of the two second-period projects, which implies he will end up refinancing either zero, one, or two projects. As can be shown, any such contract is equivalent to a contract where the investor uses a common refinancing probability for both second-period projects. (The argument rests on risk neutrality). Without loss of generality, we may thus assume that the investor pays $2I$ with probability $\beta(\hat{s})$ at date 1.

We finally need to specifiy what the firm's self-financing possibilities are if a high cash-flow firm falsely claims that the cash flow is low. Given (A.1) there are only two possibilities: i) $2(\pi_h - \pi_l) < I$, in which case the firm cannot self-finance at all, and ii) $2I > 2(\pi_h - \pi_l) > I$, in which case a high cash-flow firm can make one, but only one, second-period investment without returning to the capital market. If a high cash-flow firm could self-finance both second-period projects (A.1) would be violated, i.e., the investor would have no threat and financing would break down completely.

We begin with the case where self-financing is not possible. As we shall argue below, this case is less realistic if a firm has many projects. Still, it is useful to consider this case as there centralized borrowing has benefits but no costs, which provides an undistorted picture of the benefits of centralization. If self-financing is possible, these benefits will be weighed against the costs of self-financing. Formally, the assumption that self-financing is not possible is

(A.2) $\quad 2(\pi_h - \pi_l) < I.$

In what follows we assume that (A.1)-(A.2) holds.

The problem under centralized borrowing is to provide headquarters with incentives to reveal the true cash flow. Denote the set of possible cash flows by $S := \{(l,l), (l,h), (h,h)\}$.

The investor solves

$$\max_{\beta(s),R^1(s),R^2(s)} -2I + p^2 \left[R^1(l,l) + \beta(l,l)\left(R^2(l,l) - 2I\right)\right] \tag{4}$$
$$+2p(1-p)\left[R^1(h,l) + \beta(h,l)\left(R^2(h,l) - 2I\right)\right]$$
$$+(1-p)^2\left[R^1(h,h) + \beta(h,h)\left(R^2(h,h) - 2I\right)\right]$$

s.t.

$$r(s) - R^1(s) + \beta(s)\left[2\overline{\pi} - R^2(s)\right] \tag{5}$$
$$\geq \quad r(s) - R^1(\hat{s}) + \beta(\hat{s})\left[2\overline{\pi} - R^2(\hat{s})\right] \text{ for all } s, \hat{s} \in S,$$

$$R^1(s) \leq r(s) \text{ for all } s \in S, \tag{6}$$

and

$$R^2(s) \leq r(s) - R^1(s) + 2\pi_l \text{ for all } s \in S. \tag{7}$$

The individual rationality constraint can be again omitted as it is implied by the stronger limited liability constraints (6)-(7).

The optimal contract is derived in the Appendix. In the low and high cash-flow state the optimal contract is the same as under decentralized borrowing, except that all payments are multiplied by two. We thus have $\beta(l,l) = 0$, $R^1(l,l) = 2\pi_l$, $\beta(h,h) = 1$, $R^1(h,h) = 2\overline{\pi}$, and $R^2(h,h) = 2\pi_l$. If both first-period cash flows are low, the firm obtains no second-period financing while if both first-period cash flows are high, the firm obtains second-period financing for sure. In the intermediate case where one cash flow is low and the other is high the optimal contract is either identical to that of the high cash-flow firm (if $p \geq 1/2$), or it has $\beta(h,l) = 1/[2(1-p)] > 1/2$, $R^1(h,l) = \pi_h + \pi_l$, and $R^2(h,l) = 2\pi_l$ (if $p \leq 1/2$). The case distinction is due to the fact that for $p \geq 1/2$ the limited liability constraint (7) is slack. By contrast, if $p < 1/2$ the constraint binds, which means the investor extracts the maximum possible date-1 repayment.

The only cash-flow state where centralization makes a difference is thus the intermediate state where one cash flow is low and the other is high. In this state the refinancing probability is strictly greater than one half. By contrast, the average refinancing probability under decentralized borrowing is $[\beta(h) + \beta(l)]/2 = 1/2$. We may therefore conclude that the first type of inefficiency, viz., that efficient second-period investments are not undertaken, is less severe if borrowing is centralized.

If we insert the optimal contract in the investor's objective function (4) and solve for the value of I at which he breaks even, we obtain that the investor invests at date 0 if and only if

$$I \leq \overline{\pi} - \frac{\overline{\pi} - \pi_l}{2 - p + p^2} \tag{8}$$

if $p \leq 1/2$, and

$$I \leq \overline{\pi} - \frac{\overline{\pi} - \pi_l}{2 - p^2} \tag{9}$$

if $p \geq 1/2$. Comparing (8)-(9) with the corresponding value under decentralized borrowing, (3), we have that the second type of inefficiency, viz., that positive NPV projects are not financed at date 0, is also less severe under centralized borrowing. This holds for any value of p. The following proposition summarizes these results.

Proposition 1. *If (A.1)-(A.2) hold, centralized borrowing is optimal for all p. That is, it is optimal to have headquarters borrow on behalf of both projects and subsequently allocate the funds on the firm's internal capital market rather than have each project borrow separately on the external capital market.*

The superiority of centralization vis-a-vis decentralization is *not* based on a superior allocation of funds to projects inside the firm. At date 1 the two projects are identical in every respect. Hence there is no scope for winner-picking. Rather, the superiority of centralization derives from the fact that incentives for revealing the true date-1 cash flow can be provided more efficiently.

The argument proceeds in two steps. As contracts in the high and low cash-flow state are the same under centralized and decentralized borrowing, we can restrict attention to the intermediate state where one cash flow is low and the other is high. To facilitate the exposition, we first derive some preliminary results. When thinking about whether to reveal the true cash flow, the intermediate and high cash-flow firm compares the payoff from truthtelling with that from mimicking the low cash-flow firm. To make mimicking as costly as possible, the investor sets $\beta(l) = 0$ and $R^1(l) = \pi_l$ (under decentralized borrowing) and $\beta(l,l) = 0$ and $R^1(l,l) = 2\pi_l$ (under centralized borrowing). Moreover, it is evidently optimal to set $R^2(h) = \pi_l$ and $R^2(h,l) = R^2(h,h) = 2\pi_l$, which means the firm must pay out its entire verifiable date-2 cash flow.

Consider now the high cash-flow firm's incentive compatibility constraint under decentralized borrowing:

$$\underbrace{\pi_h - R^1(h)}_{\text{first-period rent}} + \underbrace{\beta(h)\left[\overline{\pi} - \pi_l\right]}_{\text{continuation benefit}} \geq \pi_h - \pi_l.$$

The right-hand side depicts the payoff from mimicking the low cash-flow firm. Accordingly, to induce the high cash-flow firm to reveal its cash flow, the investor must leave the firm a rent of $\pi_h - \pi_l$. (This rent is usually called *information rent*). There are two ways to provide this rent: i) by demanding a lower date-1 repayment $R^1(h)$, or ii) by offering a higher continuation benefit $\beta(h)\left[\overline{\pi} - \pi_l\right]$. From an efficiency standpoint ii) is superior as it minimizes the probability of inefficient termination. The solution is therefore to provide as much rent as possible in the form of continuation benefits. As the maximum continuation benefit under decentralized borrowing is $\overline{\pi} - \pi_l$, the remainder $\pi_h - \overline{\pi}$ must be provided in the form of first-period rent, i.e., in the form of a lower date-1 repayment.

Consider next the intermediate cash-flow firm under centralized borrowing. Its (downward) incentive compatibility constraint is

$$\underbrace{\pi_h + \pi_l - R^1(h,l)}_{\text{first-period rent}} + \underbrace{\beta(h,l)\,2\left[\overline{\pi} - \pi_l\right]}_{\text{continuation benefit}} \geq \pi_h - \pi_l.$$

The total rent that must be left to the intermediate cash-flow firm is again $\pi_h - \pi_l$. Unlike above, however, the investor can now provide a continuation benefit of up to $2\left[\overline{\pi} - \pi_l\right]$. The continuation benefit actually provided is either $2\left[\overline{\pi} - \pi_l\right]$ (if $p \geq 1/2$) or $\pi_h - \pi_l$ (if $p < 1/2$), which is both strictly greater than the corresponding value under decentralized borrowing. This is what constitutes the *fundamental advantage of centralized over decentralized borrowing.* While the total information rent is the same under centralized and decentralized borrowing, its composition is different. Under decentralized borrowing the continuation decision concerns only one project, which means a relatively large fraction of the rent must come in the form of first-period rent. By contrast, under centralized borrowing the continuation decision concerns two projects, which means most (if $p \geq 1/2$), or even all (if $p < 1/2$) of the rent can be provided in the form of continuation benefits. Our result that centralization improves contract efficiency is robust in various ways. It holds if the state space is continuous (Section 3), if the investor makes no loss in the second period (Section 3), and if cash flows are correlated (Section 4).

Another way to view the tradeoff between first- and second-period rents is in terms of *financial slack.* Any nonverifiable date-1 cash flow retained in the firm represents unused liquidity: efficiency could be improved by trading it in for continuation rights. Consider the high cash-flow firm under decentralized borrowing. After trading in $\overline{\pi} - \pi_l$, which equals the continuation benefit from its second-period investment, the firm's remaining liquidity is $\overline{\pi} - \pi_l$. If the high cash-flow manager were to share this excess liquidity with the low cash-flow firm, the latter could trade it in for continuation rights. But as each firm cares only about its own continuation decision, this does not happen.[4]

Under centralized borrowing this externality problem does not arise. As headquarters adopts a firm-wide perspective it does not care which of the two projects produces the cash flow. Effectively, headquarters uses liquidity produced by the high cash-flow project to

[4] What if the two firms write an insurance contract at date 0? Due to the nonverifiability of cash flows the high cash-flow firm *must* earn a rent of $\pi_h - \pi_l$. If the insurance contract were to oblige the high cash-flow firm to share this rent with the low cash-flow firm, the former would not reveal its true cash flow in the first place. Hence any incentive compatible contract between the two firms must lead to exactly the same allocation as here.

buy continuation rights for the low cash-flow project. (This also explains why the benefits only arise in the intermediate cash-flow state). Note that a financial intermediary such as, e.g., a bank cannot do this as it does not have direct access to the firms' cash flow. Much like the investor under decentralized borrowing, a bank would have to provide the high cash-flow firm with incentives to disgorge cash.

Finally, consider the "no self-financing" assumption (A.2) and replace 2 by n. For suficiently large n the inequality breaks down. In other words, the more projects there are under one roof, the more likely is it that the firm can undertake at least one second-period investment without returning to the capital market. We now come to the more realistic scenario where partial self-financing is possible.

Centralized Borrowing: Self-Financing

In the context of this model, self-financing means that if both date-1 cash flows are high, headquarters can undertake one second-period investment without having to raise funds from the capital market. We replace (A.2) by

(A.3) $\qquad 2I > 2(\pi_h - \pi_l) \geq I.$

In what follows we assume that (A.1) and (A.3) hold.

The fact that a high cash-flow firm can partly self-finance second-period investment tightens the firm's incentive compatibility constraint. In the absence of self-financing, the payoff from mimicking a low cash-flow firm is $2(\pi_h - \pi_l)$. However, if the firm can invest the retained cash in a second-period project, the payoff from mimicking a low cash-flow firm becomes $2(\pi_h - \pi_l) + \overline{\pi} - I$. To induce the high cash-flow firm *not* to mimick a low cash-flow firm, the investor must now additionally compensate the firm for the foregone profit of $\overline{\pi} - I$. The more general idea is that, by pooling cash flows from several projects, centralized firms may accumulate internal funds and make follow-up investments without having to return to the capital market. This weakens the investor's termination threat, which in turn tightens financing constraints ex ante.

If we solve the investor's expected profit for the value of I at which he breaks even, we have that the investor invests at date 0 if and only if

$$I \leq \overline{\pi} - \frac{\overline{\pi} - \pi_l}{1 + p + \frac{(1-p)^2}{2}}, \tag{10}$$

if $p \leq 1/2$, and

$$I \leq \overline{\pi} - \frac{\overline{\pi} - \pi_l}{1 + 2p(1-p) + \frac{(1-p)^2}{2}} \tag{11}$$

if $p \geq 1/2$. Comparing (10)-(11) with the corresponding value under decentralized borrowing, (3), we obtain the following result.

Proposition 2. *If (A.1) and (A.3) hold, centralized borrowing where headquarters borrows on behalf of both projects is optimal if* $p \geq \sqrt{2} - 1$. *By contrast, if* $p \leq \sqrt{2} - 1$ *it is optimal to have each project borrow separately on the external capital market.*

Self-financing makes it more costly for the investor to induce the firm to reveal its true cash flow, which is captured by the additional "bribe" $\overline{\pi} - I$ in the high cash-flow state. The costs of centralization thus depend on the distribution of cash flows in two ways. First, the probability of the high cash-flow state is decreasing in p. Second, the additional bribe in this state is also decreasing in p. Proposition 2 shows that if p is sufficiently small, the costs of centralization outweigh the benefits. To relax financing constraints, the firm should then optimally decentralize, or what is equivalent, disintegrate. As a single-project firm does not generate enough funds to self-finance second-period investment, it must necessarily revisit the capital market. Hence decentralization acts as a credible commitment vis-a-vis investors to stay on a tight leash.[5] The notion that firms may benefit from committing to a policy of revisiting the capital market is not new and has been used as an explanation for, e.g., why firms pay dividends (Easterbrook 1984) or issue debt (Jensen 1986). In showing that a firm's organizational structure may act as a commitment to revisit the capital market, our argument complements these arguments.

Finally, the investor cannot legally prevent the firm from self-financing as both cash flows and investment decisions are nonverifiable. While the assumption that investment decisions are nonverifiable may be realistic in some cases, in particular if the firm consists of a complex bundle of investments where it is difficult for outsiders to ascertain whether the $i-$th investment has been made or not, it is less realistic in other cases. In Section 3 we show that the assumption that investment decisions are nonverifiable is not needed if the parties can renegotiate after default.

Proposition 2 admits an alternative interpretation which goes beyond the issue of financing constraints. It applies to settings where managers can withhold cash flow from both investors *and* the firm's owner(s). This may be because managers are better informed or ownership is dispersed, implying that shareholders, while having formal control rights, have insufficient incentives to enforce their claims. Under this scenario the firm's founder is in the same boat as the investor: unless management can be incentivized to pay out cash, neither the investor nor the founder will see any of it. The contract underlying Proposition 2 remains optimal in this setting as it maximizes the cash flow extracted by outsiders. The boundaries of the firm also remain the same.

[5] If both first-period cash flows are high, the two firms have a strong incentive to re-merge at date 1. To commit not to merge again, the firms may write a covenant into their debt contract restricting merger activity. Such covenants are common. For instance, Smith and Warner (1979) find that 39.1% of the public debt issues in their sample include covenants restricting merger activity.

3 General Discussion

Continuous Cash-Flow Distribution

The argument that one project may not generate enough cash to allow self-financing but two projects may is evidently independent of the cash-flow distribution. This is not so obvious with regard to the benefits of centralization, i.e., the argument that financial contracts with centralized firms are more efficient.

Suppose cash flows are continuously distributed with support $[\pi_l, \pi_h]$. Consider first the case where borrowing is decentralized. It is easily shown that the optimal contract has $\beta(\pi) = 1$ and $R^1(\pi) = \overline{\pi}$ if $\pi \geq \overline{\pi}$, and $\beta(\pi) = (\pi - \pi_l) / (\overline{\pi} - \pi_l)$ and $R^1(\pi) = \pi$ if $\pi < \overline{\pi}$ (e.g., Bolton and Scharfstein 1990; DeMarzo and Fishman 2000). The optimal contract thus resembles a standard debt contract with face value $\overline{\pi}$ and liquidation probability $1 - \beta(\pi)$. Consider next centralized borrowing. The firm's "type" is fully characterized by the sum $\omega := \pi_1 + \pi_2$, where π_1 and π_2 are the two first-period cash flows. Again, it is straightforward to show that the optimal contract has $\beta(\omega) = 1$ and $R^1(\omega) = 2\overline{\pi}$ if $\omega \geq 2\overline{\pi}$, and $\beta(\omega) = (\omega - 2\pi_l) / 2(\overline{\pi} - \pi_l)$ and $R^1(\omega) = \omega$ if $\omega < 2\overline{\pi}$. The optimal contract is again a standard debt contract, now with face value $2\overline{\pi}$ and liquidation probability $1 - \beta(\omega)$.

If either $\pi_1 \leq \overline{\pi}$ and $\pi_2 \leq \overline{\pi}$ or $\pi_1 \geq \overline{\pi}$ and $\pi_2 \geq \overline{\pi}$, i.e., if both cash flows are either low or high, the refinancing probability under centralized borrowing is identical to the average refinancing probability under decentralized borrowing, $[\beta(\pi_1) + \beta(\pi_2)] / 2$. In all other (i.e., intermediate) cash-flow states, the refinancing probability is strictly greater under centralized borrowing. The first type of inefficiency, viz., that efficient second-period investments are not undertaken, is therefore less severe under centralized borrowing.

We can again solve for the value of I at which the investor breaks even. Again, we find that the second type of inefficiency, viz., that positive NPV projects are not financed at date 0, is less severe under centralized borrowing if and only if the expected refinancing probability is higher. By the above argument, this is the case if and only if

$$\Pr(\pi_i < \overline{\pi} \mid \pi_j \geq \overline{\pi}) > 0 \text{ for } i \neq j, \tag{12}$$

i.e., if there is a nonzero probability that one cash flow is below and the other is above the mean. Proposition 1 thus extends to arbitrary continuous cash-flow distributions satisfying (12). If (12) does not hold the organizational structure is irrelvant. Clearly, (12) holds if the joint distribution $F(\pi_1, \pi_2)$ has full support. Conversely, (12) does not hold if π_1 and π_2 are perfectly positively correlated.

No Investor Loss in Second Period

Our result that centralization improves contract efficiency does not depend on the fact that the investor makes a loss in the second period. To see this, denote the verifiable second-period cash flow by $\pi_l' \geq \pi_l$ and the corresponding expected second-period cash flow by $\overline{\pi}' := p\pi_l' + (1-p)\pi_h$. The verifiable first-period cash flow is still $\pi_l < I$.

As can be shown, centralized borrowing is optimal if and only if

$$\pi_l' < I + (1-p)(\overline{\pi}_l' - I)$$

where the right-hand side is strictly greater than I. Accordingly, Proposition 1 extends to situations where the verifiable second-period cash flow exceeds the investment cost. (If the inequality is reversed there is no inefficiency: the verifiable cash flow is so large that − even under decentralized borrowing − the firm is refinanced with probability one).

Nonverifiability of Investment Decisions

Our assumption that investment decisions are nonverifiable is not needed if the parties can renegotiate after default. Consider a Hart-Moore (1998) type setting where upon default the investor seizes the assets underlying the project (e.g., a machine). To bring the story in line with our model, suppose the asset value corresponds to the verifiable cash-flow component π_l. The investor then has the choice between selling the asset on the market or renegotiating ownership. If the investor sells the asset on the market, he receives π_l. If he sells the asset back to the firm, he receives some price P.

If the asset is sold back to the firm it may be used for another period, where it generates a nonverifiable return of $\pi_l + \Delta$. At the end of the second period the liquidation value is zero, i.e., there is full depreciation. We shall assume that $\Delta > 0$, i.e., the asset is worth more to the firm than to the market, which implies that date-1 liquidation is inefficient. As Hart and Moore (1998) point out, however, the firm may not have enough funds to compensate the investor for not liquidating the asset.

Suppose $2(\pi_h - \pi_l) > \pi_l > (\pi_h - \pi_l)$, where the first inequality follows from (A.3). In this case neither of the two stand-alone firms has sufficient funds to buy back the asset. However, the centralized firm, after earning $2\pi_h$ but claiming that the cash flow is $2\pi_l$, does have sufficient funds, which means there will be renegotiation. Depending on the distribution of bargaining powers and the firm's liquidity, the outcome of the renegotiation is that the high cash-flow firm makes an additional net gain of $\pi_l + \Delta - P \geq 0$.[6] In a renegotiation-proof contract the investor must therefore pay the high cash-flow firm under centralized borrowing a greater rent than the two high cash-flow firms under decentralized borrowing together. Even though investment decisions are verifiable (the use of the asset in the second period is observable) and the investor can prevent the firm from continuing

[6] The inequality may be strict even if the investor has all the bargaining power in the renegotiation. For instance, suppose $2(\pi_h - \pi_l) = \pi_l + \Delta/2$. In this case, the investor can extract at most half of the surplus since $\pi_l + \Delta/2$ is the most that headquarters can pay.

by liquidiating the asset, we have again that centralization lowers the investor's profit in the high cash-flow state, which is really all that is needed for Proposition 2 to hold.

Renegotiation

While the optimal contract under both centralized and decentralized borrowing entails inefficiencies, there will be no renegotiation on the equilibrium path as the maximum which the investor can assure in the second period is $\pi_l < I$. The situation is different if the high cash-flow firm claims that the cash flow is low. Consider, for instance, the high cash-flow firm under decentralized borrowing. Upon claiming that the cash flow is low, the firm pays out π_l, which implies its remaining cash flow is $\pi_h - \pi_l$. While this is not enough to self-finance second-period investment, the firm can renegotiate and ask the investor for additional funds of $I - (\pi_h - \pi_l) < \pi_l$. As the investor can assure a date-2 repayment of π_l, he is willing to provide these funds. A similar reasoning holds for the high- and intermediate cash-flow firm under centralized borrowing. In a renegotiation-proof contract the investor must therefore pay high- and intermediate cash-flow firms an additional rent. Besides, however, nothing changes. In particular, as long as the investor has sufficient bargaining power in the renegotiation, the tradeoff is the same as in the monopoly case.[7]

Competitive Credit Markets

Introducing competitive credit markets mitigates the underinvestment problem but does not eliminate it. For instance, $\beta(l)$ is no longer equal to zero but strictly between zero and one. As our results depend largely on a comparison with this benchmark, they lose much of their simplicity. Besides, there are no significant changes. In particular, both the underinvestment problem and the tradeoff analyzed here remain. One minor change is that the contract between the firm and the investor must be augmented by a seniority provision (both under centralized and decentralized borrowing). To see this, suppose the high-cash flow firm under decentralized borrowing defaults and approaches a new investor. As the firm needs only $I - (\pi_h - \pi_l) < \pi_l$ to finance second-period investment, the new investor is willing to help out. But this means that the original investor will make a loss. A seniority provision stating that the firm cannot make a repayment to a new investor unless it has fully settled its debt with the original investor avoids this problem. As payments to and from investors are verifiable, this provision is enforceable.

Related Literature

A paper closely related to ours is Stein (1997). In his model winner-picking creates value even if the financing constraint is unchanged. By contrast, in our model value is only

[7] If the firm has all the bargaining power, the investor's payoff from each project is $-I + \pi_l < 0$. Hence financing breaks down completely, much like when there is only a single period.

created if the financing constraint is relaxed, which is the case if the benefits of cash-flow pooling outweigh the costs. The costs and benefits of centralization are thus different sides of the same coin. By contrast, in Stein's model the costs of centralization are loss of oversight if headquarters oversees too many projects. Finally, in Stein's model there is no relation between the productivity of conglomerates and their propensity to access external finance. By contrast, in our model there is an inverse relation.

Scharfstein and Stein (2000) and Rajan, Servaes, and Zingales (2000) also examine the costs of centralization, but from a different angle. Both papers stress the role of power struggles between division managers and headquarters as a potential source of intra-firm capital misallocation. In our model there is no intra-firm capital misallocation; the sole inefficiency is that the firm as a whole may not get enough funds. Empirically, both papers make predictions relating divisional investment to the divisions' opportunities. In our basic model opportunities are the same across divisions, which is an assumption we make to abstract from winner-picking effects. Rather, we make predictions relating divisional investment to past division cash flows.

Berkovitch, Israel, and Tolkowsky (2000) and Matsusaka and Nanda (2000) also study the link between internal capital markets and firm boundaries. In the first paper headquarters has unlimited funds, which implies financing constraints play no role. The paper predicts that, under reasonable assumptions, conglomerates have a higher productivity than stand-alones, which is the opposite of what we predict. Matsusaka and Nanda assume that external finance entails a deadweight loss. In particular, they assume that the deadweight loss is the same for conglomerates and stand-alones, which is precisely what we question in this paper. Finally, our paper is not the first to show that cash-flow pooling may alleviate agency problems. Papers analyzing this are, e.g., Diamond (1984), Li and Li (1996), and Fluck and Lynch (1999). None of these papers, however, has a tradeoff where cash-flow pooling has both endogenous costs and benefits at the same time.

4 Which Projects Should Be Pooled?

In this section we examine the decision to pool projects from different angles. The empirical implications following from this are discussed in Section 5.

Correlation

We admit arbitrary correlation across cash flows in a given period while retaining the assumption that cash flows are serially uncorrelated. Denote the correlation coefficient by ρ. While the optimal contracts under both self-financing and "no self-financing" remain unchanged, introducing correlation alters the probabilities of the different cash-flow states, and therefore the investor's expected payoff. (Intuitively, the optimal contracts remain unchanged as incentive compatibility and limited liability are both ex-post constraints that do not depend on the ex-ante probabilities). The new probabilities are $p\left[1-(1-\rho)(1-p)\right]$ for the low cash-flow state, $2(1-\rho)\,p\,(1-p)$ for the intermediate cash-flow state, and $(1-p)\left[1-p(1-\rho)\right]$ for the high cash-flow state. The Appendix contains a derivation of these probabilities.

If self-financing is not possible, the result is clear. As centralization has only benefits but no costs, centralized borrowing is strictly optimal, except when $\rho = 1$. If $\rho = 1$ the probability of the intermediate cash-flow state is zero, and the organizational structure is irrelevant. If self-financing is possible the result is as follows.

Proposition 3. *Suppose (A.1) and (A.3) hold. Decentralized borrowing is optimal if* $\rho \geq 2/3$ *while centralized borrowing is optimal if* $\rho \leq -1/2$*. If* $\rho \in (-1/2, 2/3)$ *there exists a strictly increasing function* $\overline{p}(\rho)$ *such that decentralized borrowing is optimal if* $p \leq \overline{p}(\rho)$ *and centralized borrowing is optimal if* $p \geq \overline{p}(\rho)$*.*

As $\rho \to 1$ the probability of the intermediate cash-flow state goes to zero while the probability of the high cash-flow state remains positive. Hence centralization has costs but no benefits. Conversely, if $\rho \to -1$ the probability of the high cash-flow state goes to zero while the probability of the intermediate cash-flow state approaches one.[8] For intermediate values of ρ we have the same picture as before: while neither organizational form completely dominates the other, there exists a critical value $\overline{p}(\rho)$ such that centralized borrowing is optimal if $p \geq \overline{p}(\rho)$ and decentralized borrowing is optimal if $p \leq \overline{p}(\rho)$. The reader may verify from the Appendix that $\overline{p}(0) = \sqrt{2} - 1$.

High vs. Low Future Profitability

Is conglomeration more beneficial in industries where expected future profits are low or high? To answer this question, we introduce separate probabilities $-$ and hence profitabilities $-$ for each period. Denote the probability of the low cash flow in period t by p_t and the corresponding expected cash flow by $\overline{\pi}_t$. While we no longer assume that the two periods are the same, we retain the assumption that the two projects are identical. Heterogeneous project bundles are considered below. We have the following result.

Proposition 4. *Suppose (A.1) and (A.3) hold. If* $p_2 \leq 1/2$ *centralized borrowing is optimal if and only if* $p_1 \geq (1-p_2)/(1+p_2)$*. By contrast, if* $p_2 \geq 1/2$ *centralized borrowing is optimal if and only if* $p_1 \geq 1/3$*.*

[8] Due to the two-point distribution, not all (ρ, p)-combinations are feasible. In particular, if $\rho = -1$ the only feasible $p-$value is $p = 1/2$, which explains why the probability of the high cash-flow state goes to zero as $\rho \to -1$. The set of feasible (ρ, p)-combinations is derived in the Appendix.

If the first-period profitability is sufficiently high, centralized borrowing is never optimal. For all other values of p_1 there exists a critical p_2-threshold such that decentralized borrowing is optimal if p_2 is low and centralized borrowing is optimal if p_2 is high. Intuitively, if the follow-up investment is unattractive, the incentives to engage in self-financing are small, implying that centralized firms can be disciplined at a comparatively low cost. In this case, the benefits of centralization outweigh the costs. By contrast, if the follow-up investment is attractive, the incentives to engage in self-financing, and thus the bribe that must be paid to the high cash-flow firm, are high.

Cash-Flow Balancing

The termination threat is based on an exchange: the firm exchanges first-period cash flow (thereby giving up first-period rents) for second-period continuation rights. The termination threat is thus most effective if there is a balance between first-period cash flow and continuation rights. If the continuation value is high but the first-period cash flow is low, the firm can only buy a small fraction of the continuation rights. Similarly, if the first-period cash flow is high but the continuation value is low, the firm will only pay out a small fraction of its cash flow equal to the continuation value. (Centralization mitigates this problem by raising the continuation value).

The above argument suggests that if projects are strongly front- (high $\overline{\pi}_1$ but low $\overline{\pi}_2$) and backloaded (low $\overline{\pi}_1$ but high $\overline{\pi}_2$), it may be better to pool one front- and one backloaded project rather than two front- or two backloaded projects. The idea is that the high cash flow generated by the frontloaded project can be used to buy continuation rights for the (valuable) second tranche of the backloaded project. This intuition can be formalized. Suppose the probability of the low cash flow can take two values: p_H and p_L, where $p_H > p_L$. Frontloaded projects have $p_1 = p_L$ and $p_2 = p_H$, implying that $\overline{\pi}_1 = \overline{\pi}_L > \overline{\pi}_H = \overline{\pi}_2$. Backloaded projects have $p_1 = p_H$ and $p_2 = p_L$, implying that $\overline{\pi}_1 = \overline{\pi}_H < \overline{\pi}_L = \overline{\pi}_2$. The expected two-period cash flow is the same for both projects. We obtain the following result.

Proposition 5. *Suppose (A.1) and (A.3) hold. If* $\overline{\pi}_L - \overline{\pi}_H$ *is sufficiently large, implying that projects are sufficiently front- and backloaded, it is optimal to pool one front- and one backloaded project rather than two front- or two backloaded projects.*

The result is reminiscent of the *portfolio matrix* developed by the Boston Consulting Group in the 1970s. Like here, projects with high short-term cash ("cash cows" in BCG's language) are used to finance growth projects. A fundamental difference is that the portfolio matrix, like other concepts where internal cash flow is being recycled, rests on the notion that firms must use internal funds, e.g., because external finance is too costly. By contrast, in this paper the recycling channel goes via the external capital market: firms make repayments and subsequently raise new funds. Balancing cash-flow maturities ensures that i) firms are *capable* of making the repayment, and ii) firms are *willing* to make the repayment to safeguard the continuation of profitable projects.

Proposition 5 has implications for investment policy. To maintain a balanced portfolio, firms may have to forego profitable projects in favor of projects which are less profitable but have a more favorable cash-flow pattern. To give an extreme example of cash-flow balancing, suppose there are two kinds of projects: frontloaded projects generating an expected cash flow of $\overline{\pi}$ in the first period and zero in the second period, and backloaded projects generating zero in the first period and an expected cash flow of $\overline{\pi}$ in the second period. For simplicity, suppose in periods where no cash flow is generated the investment cost is zero. Both projects are then effectively one-period projects. From Bolton and Scharfstein (1990) we know that neither the front- nor the backloaded project alone, nor a bundle consisting of two front- or two backloaded projects, can raise external finance. By contrast, a bundle consisting of one front- and one backloaded project can raise external finance if the investment condition (3) holds.

5 Empirical Implications

This section summarizes the empirical implications. The first implication follows directly from the optimal contract. Consider a low cash-flow project (or division). If the cash flow of the other project is also low, the refinancing probability is zero. By contrast, if the cash flow of the other project is high, the refinancing probability is between 1/2 and 1. The argument for the high cash-flow project is analogous.

Implication 1. *Divisional investment is positively related to the cash flow of other divisions.*

Supporting evidence is provided by Lamont (1997) and Shin and Stulz (1998). Lamont studies the reaction of US oil companies to the 1986 oil price decline. He finds that a lower cash flow in the firms' core business leads to investment cuts in non-oil-related divisions. Similarly, Shin and Stulz find that the investment of smaller divisions is positively related to the cash flow of other divisions.

In our model, the fraction of nonverifiable cash flow $\pi_h - \pi_l$ measures the magnitude of the agency problem between the firm and the investor. If all cash flow is verifiable there is no value to project pooling. If some, but not too much cash flow can be diverted, project pooling is unambiguously valuable. Finally, if enough cash flow can be diverted to self-finance follow-up investments, the value of project pooling declines. All together, this suggests a hump-shaped relationship between the magnitude of the agency problem and the value of project pooling.

Implication 2. *Internal capital markets are most valuable if agency problems between firms and investors are small (but positive), and less valuable if they are large.*

The result contrasts with Stein's (1997) result that internal capital markets are most valuable if agency problems are severe. The empirical evidence on this issue is mixed. Consistent with Stein's argument, Hubbard and Palia (1999) find that the highest bidder returns in diversifying acquisitions in the 1960s were earned when financially unconstrained buyers acquired constrained target firms. The authors take this as evidence that capital markets viewed the formation of conglomerates as a response to the information deficiencies of external capital markets, which were arguably greater in the 1960s. On the other hand, Servaes (1996) finds that conglomerates traded at a substantial discount in the 1960s, which is difficult to reconcile with Hubbard and Palia's interpretation.

Rather than going back in time, several papers study the value of conglomeration in countries where capital markets are less developed. Lins and Servaes (2001) obtain a substantial diversification discount for seven emerging markets countries, which is of the same order of magnitude as that found by Lang and Stulz (1994) for the US. Similarly, Claessens, Djankov, Fan, and Lang (1999) find no clear pattern of different degrees of diversification across countries at different levels of development. Both authors reject the hypothesis that greater information asymmetries and market imperfections make internal capital markets more valuable.[9]

We now come to the core implications of our model. The next two implications relate a firm's propensity to access external finance to exogenous characteristics such as operating productivity and the degree of firm diversification.

Implication 3. *Low-productivity conglomerates should have a higher, and high-productivity conglomerates should have a lower propensity to access external finance than comparable stand-alone firms.*

Implication 4. *The propensity of conglomerates to access external finance should be positively related to their degree of diversification.*

Implication 3 follows from the analysis leading to Proposition 2. It derives from a comparison of the investment thresholds under decentralized and centralized borrowing. Implication 4 follows from the analysis leading to Proposition 3. Unlike Implication 3,

[9] Khanna and Palepu (2000) find that Indian firms affiliated with highly diversifed business groups outperform other firms. The authors point out, however, that internal capital markets have nothing to do with this. Unlike, e.g., Japanese keiretsu, Indian business groups have no common internal capital market.

it does not compare stand-alones and conglomerates, but conglomerates with different project correlations.

We are not aware of any empirical test of Implication 3. Although Comment and Jarrell (1995) and Peyer (2001) both find that conglomerates and stand-alones have different propensities to access external finance, neither paper compares low- and high-productivity (or low- and high-performance) firms separately.[10] Implication 4 seems to be consistent with the empirical evidence. While Comment and Jarrell (1995) find that highly and less diversified conglomerates have similar propensities to access external capital markets, their analysis does not control for internal capital markets efficiency. Peyer (2001) refines Comment and Jarrell's analysis by discriminating between firms with efficient and inefficient internal capital markets. He finds that − if the internal capital allocation is efficient (which is the case in our model) − the propensity of conglomerates to access external finance increases with the degree of firm diversification.

Implications 1-4 are general statements which hold regardless of whether the organizational form is chosen optimally. The next two implications rest on the assumption that the organizational form is chosen optimally. Implication 5 is a direct corollary to Proposition 2, which is the central result of our paper.

Implication 5. *Conglomerates should on average have a lower operating productivity than stand-alone firms.*

Implication 5 suggests that the diversification decision is endogenous: low-productivity firms diversify while high-productivity firms do not. There exists strong empirical support for this argument. Using plant-level data, Maksimovic and Phillips (2001) find that − for all but the smallest firms in their sample − conglomerate firms in the US are less productive than single-segment firms. (The smallest size category constitutes 3.3% of their sample). Similarly, Berger and Ofek (1995) (for the US) and Lins and Servaes (2001) (for emerging markets countries) find that diversified firms have a smaller operating profitability than stand-alone firms, and Lang and Stulz (1994) find that diversifying firms are poor performers relative to firms that do not diversify. Finally, Campa and Kedia (1999) and Graham, Lemon, and Wolff (2001) find that diversifying firms trade at a discount already prior to the diversification, and that targets in diversifying acquisitions are already discounted before they are acquired, respectively. Contrary evidence is provided by Schoar (2000), who finds that plants of diversified firms are more productive than plants of single-segment firms.

[10] Comment and Jarrell (1995) find that conglomerates use less external finance than single-segment firms, although the difference is small. Peyer (2001) finds that conglomerates with efficient internal capital markets use more external finance than single-segment firms. Our model would suggest that differences in productivity might be able to explain some of the cross-sectional variation in these studies.

The next statement follows from Proposition 4. It rests on the notion that the incentives to engage in self-financing, and hence the costs of centralization, are lower if the follow-up investment is relatively unattractive.

Implication 6. *Compared to stand-alone firms, conglomerate firms should be more prevalent in slow-growing or declining industries.*

Few studies have examined the relation between conglomeration and industry growth. Consistent with our hypothesis, Lang and Stulz (1994) find that diversified firms tend to be concentrated in industries with fewer growth opportunities. Similarly, Burch, Nanda, and Narayan (2000) report a negative correlation between industry conglomeration and investment opportunities as measured by industry market-to-book ratios.

The last implication follows from Proposition 5. Unlike Implication 6, it does not compare stand-alones and conglomerates, but different investment policies for conglomerates.

Implication 7. *Conglomerates operating in both growing and declining industries should have a higher propensity to access external finance than conglomerates operating either in growing or declining industries.*

While based on a different logic than models of internal cash-flow recycling, the implications for investment policy are similar: firms should hold a balanced portfolio of projects generating immediate cash ("cash cows") and projects generating cash in the future ("growth projects"). We are not aware of empirical work examining the relation between financing constraints and the composition of firms' investment portfolios.

6 Concluding Remarks

Financial contracting models typically consider an entrepreneur who raises funds for a single project. In this setting, questions regarding organizational structure or the role of internal capital markets cannot be addressed. On the other hand, internal capital markets models, while analyzing the choice between centralization and decentralization, do not consider optimal contracts between headquarters and outside investors. This paper links both literatures, thereby tying together in- and external capital markets.

We derive the optimal contract for both centralized firms where headquarters borrows on behalf of multiple projects and decentralized, or stand-alone, firms where individual project managers borrow separately. Centralization has benefits and costs. On the benefit side, headquarters uses excess liquidity from high cash-flow projects to buy continuation rights for low cash-flow projects. This, in turn, allows headquarters to make greater repayments, which relaxes financing constraints ex ante. On the cost side, headquarters may pool cash flows from several projects and pursue follow-up investments without having to return to the capital market. This makes it more difficult for investors to discipline the firm in the future, which tightens financing constraints ex ante.

We believe our model yields insights which may be applied to other areas of economics and finance. By showing that cash-flow pooling can strengthen a firm's ability to expropriate investors, the paper is one of few papers emphasizing the potential costs of cash-flow pooling. Other models, especially in the financial intermediation literature, rest largely on the benefits of cash-flow pooling (e.g., Diamond 1984). Introducing costs in these models may generate new, interesting insights. Second, internal capital markets, via their effect on financing constraints, may affect the strategic behavior of firms in the product market. For instance, in Bolton and Scharfstein (1990) the presence of financing constraints creates incentives for deep-pocket firms to lower the profits of financially constrained rivals. Forming a conglomerate can reduce financing constraints and therefore competitors' incentives to prey. Third, internal capital markets may play an important role for the credit channel and monetary transmission mechanism. In particular, to the extent that they alleviate credit constraints, internal capital markets may damp the effect of shocks on business lending and hence stabilize production and economic growth.[11]

7 Appendix

Proof of Proposition 1. It remains to derive the optimal contract under centralized borrowing given (A.1)-(A.2). The rest follows from the argument in the text.

Instead of solving the problem (4)-(7) we solve a relaxed problem where the global incentive compatibility constraint (5) is replaced with the downward constraints that neither type (h,h) nor type (h,l) has an incentive to mimic type (l,l). We subsequently show that the solution to this relaxed problem also solves the original problem. In the relaxed problem the investor solves (4) subject to the limited liability constraints (6)-(7) and the downwards incentive compatibility constraints

$$r(s) - R^1(s) + \beta(s)\left[2\overline{\pi} - R^2(s)\right] \geq r(s) - R^1(l,l) + \beta(l,l)\left[2\overline{\pi} - R^2(l,l)\right],$$

where $s \in \{(h,h),(h,l)\}$. Denote these constraints by $C(h,h)$ and $C(h,l)$, respectively. The following two lemmas considerably simplify the analysis.

Lemma. *At any optimum it must hold that $\beta(l,l) = 0$ and $R^1(l,l) = 2\pi_l$.*

Proof. We argue to a contradiction. Suppose $\beta(l,l) > 0$ and define $\bar{R}^1(l,l) := 2\pi_l$ and $\bar{R}^2(l,l) := R^2(l,l) - 2\pi_l + R^1(l,l)$. If $\beta(l,l) < 1$ replacing $R^1(l,l)$ and $R^2(l,l)$ with $\bar{R}^1(l,l)$ and $\bar{R}^2(l,l)$ strictly increases the investor's expected profit, whereas if $\beta(l,l) = 1$

[11] On the macroeconomic implications of credit constraints, see Bernanke, Gertler, and Gilchrist (2000).

replacing $R^1(l,l)$ and $R^2(l,l)$ with $\bar{R}^1(l,l)$ and $\bar{R}^2(l,l)$ leaves the investor's expected profit unchanged. Moreover, if $C(h,h)$, $C(h,l)$, and the two limited liability constraints are satisfied under $R^1(l,l)$ and $R^2(l,l)$, they are also satisfied under $\bar{R}^1(l,l)$ and $\bar{R}^2(l,l)$.

From the second-period limited liability constraint for type (l,l) it follows that $\bar{R}_i^2(l,l) - 2I < 0$. On the other hand, since $\bar{\pi} - I > 0$ and $\bar{R}^2(l,l) \leq 2\pi_l$ it must be true that $2\bar{\pi} - \bar{R}^2(l,l) > 0$. Accordingly, reducing $\beta(l,l)$ strictly improves the investor's expected profit without violating any of the incentive compatibility constraints, which contradicts the optimality of $\beta(l,l) > 0$. Given that $\beta(l,l) = 0$ is optimal, the fact that $R^1(l,l) = 0$ is also optimal is obvious. Q.E.D.

Lemma. *At any optimum the constraints $C(h,l)$ and $C(h,h)$ must bind.*

Proof. We argue again to a contradiction. Suppose $C(h,h)$ is slack. If $\beta(h,h) = 0$ then $C(h,h)$ implies that the first-period limited liability constraint for type (h,h) is also slack. But this implies that the investor can improve his expected profit by raising $R^1(h,h)$ without violating any constraint, contradiction. If $\beta(h,h) \in (0,1)$ the unique optimal payments for type (h,h) are $R^1(h,h) = \pi_l + \pi_h$ and $R^2(h,h) = 2\pi_l$. Since we showed above that $R^1(l,l) = 2\pi_l$ and $\beta(l,l) = 0$ this violates $C(h,h)$, contradiction. Finally, if $\beta(h,h) = 1$ any optimal contract must satisfy $R^1(h,h) + R^2(h,h) = 2\pi_h + 2\pi_l$. Since $2(\pi_h - \pi_l) > 2(\bar{\pi} - \pi_l)$ this violates $C(h,h)$, contradiction.

Next, suppose $C(h,l)$ is slack. If $\beta(h,l) = 0$ the argument is the same as above. If $\beta(h,l) \in (0,1)$ the unique optimal payments for type (h,l) are $R^1(h,l) = \pi_h + \pi_l$ and $R^2(h,l) = 2\pi_l$. Observe that if $2\beta(h,l)(\bar{\pi} - \pi_l) \geq \pi_h - \pi_l$ this contract is indeed incentive compatible. Since $2(\pi_l - I) < 0$, however, the investor is strictly better off by reducing $\beta(h,l)$, contradiction. Finally, if $\beta(h,l) = 1$ any optimal contract must satisfy $R^1(h,l) + R^2(h,l) = \pi_h + \pi_l + 2\pi_l$. In particular, this implies that any optimal contract yields the same profit to the investor as a contract where $R^1(h,l) = \pi_h + \pi_l$ and $R^2(h,l) = 2\pi_l$. As we showed above, however, the investor would then want to decrease $\beta(h,l)$, contradiction. Q.E.D.

The first of the above lemmas implies that the lowest type (l,l) receives no rent in equilibrium. The second lemma is a standard feature of contracting problems of this sort. Equipped with these two lemmas we can now derive the optimal contract.

Lemma. *The following contract is optimal*:

1) *Type* $(l,l) : \beta(l,l) = 0$ *and* $R^1(l,l) = 2\pi_l$.

2) *Type* $(l,h) : \beta(h,l) = 1/[2(1-p)]$, $R^1(h,l) = \pi_h + \pi_l$, *and* $R^2(h,l) = 2\pi_l$ *if* $p \leq 1/2$, *and* $\beta(h,l) = 1$, $R^1(h,l) = 2\bar{\pi}$, *and* $R^2(h,l) = 2\pi_l$ *if* $p \geq 1/2$.

3) *Type* $(h,h): \beta(h,h)=1,\ R^1(h,h)=2\overline{\pi},$ *and* $R^2(h,h)=2\pi_l.$

Proof. Setting $\beta(l,l)=0$ and $R^1(l,l)=2\pi_l$ and inserting the binding $C(h,l)$ and $C(h,h)$ constraints in (4) we can rewrite the objective function as

$$-2(\pi_l - I) + 2\pi_l + 4p(1-p)\beta(h,l)(\overline{\pi}-I) + 2(1-p)^2\beta(h,h)(\overline{\pi}-I). \qquad (13)$$

By inspection, (13) is strictly increasing in both $\beta(h,l)$ and $\beta(h,h)$, implying that the solution is $\beta(h,l)=\beta(h,h)=1$ if feasible. If $2\bar{\pi} \leq \pi_h + \pi_l$ setting $\beta(h,l)=\beta(h,h)=1$ is indeed feasible. The optimal payments $R^1(h,l)$, $R^2(h,l)$, $R^1(h,h)$, and $R^2(h,h)$ then follow from $C(h,l)$, $C(h,h)$, and the respective limited liability constraints.

If $2\bar{\pi} > \pi_h + \pi_l$ setting $\beta(h,l)=1$ violates either $C(h,l)$ or the second-period limited liability constraint for type (h,l). Accordingly, we must have $\beta(h,l)<1$. Next, observe that $2\overline{\pi} > R^2(h,l)$. To see this, suppose to the contrary that $2\overline{\pi} \leq R^2(h,l)$. Subtracting the binding $C(h,l)$ constraint from the second-period limited liability constraint for type (h,l) gives

$$\pi_h + \pi_l \geq R^2(h,l) + \beta(h,l)\left[2\overline{\pi} - R^2(h,l)\right]. \qquad (14)$$

If $2\overline{\pi} = R^2(h,l)$ this violates $2\bar{\pi} > \pi_h + \pi_l$, contradiction. Suppose therefore that $2\overline{\pi} < R^2(h,l)$. Solving (14) for $\beta(h,l)$ we have $\beta(h,l) \geq \left[\pi_h + \pi_l - R^2(h,l)\right] / \left[2\overline{\pi} - R^2(h,l)\right]$, which is strictly greater than one since $2\overline{\pi} < R^2(h,l)$ and $2\bar{\pi} > \pi_h + \pi_l$ together imply that $\pi_h + \pi_l < R^2(h,l)$, contradiction. Solving the binding $C(h,l)$ constraint for $\beta(h,l)$ we obtain $\beta(h,l) = \left[R^1(h,l) - 2\pi_l\right] / \left[2\overline{\pi} - R^2(h,l)\right]$. Moreover, since $2\overline{\pi} > R^2(h,l)$ it must hold that $\partial\beta(h,l)/\partial R^1(h,l) > \partial\beta(h,l)/\partial R^2(h,l) > 0$, implying that both the first- and second-period limited liability constraint for type (h,l) must bind. Solving the binding limited liability constraints for $R^1(h,l)$ and $R^2(h,l)$ we have $R^1(h,l) = \pi_h + \pi_l$ and $R^2(h,l) = 2\pi_l$. Inserting these values in $\beta(h,l) = \left[R^1(h,l) - 2\pi_l\right] / \left[2\bar{\pi} - R^2(h,l)\right]$ yields

$$\beta(h,l) = \frac{\pi_h - \pi_l}{2(\overline{\pi} - \pi_l)} = \frac{1}{2(1-p)}, \qquad (15)$$

where the second equality follows from the definition of $\overline{\pi}$.

It remains to show that the solution to the relaxed problem also solves the original problem (4)-(7). Since $C(h,l)$ and $C(h,h)$ are both binding, all other incentive compatibility constraints must bind as well, which implies that the solution is globally incentive compatible. Q.E.D.

Proof of Proposition 2. It remains to derive the optimal contract under centralized borrowing given (A.1)-(A.3). The rest follows from the argument in the text.

Lemma. *The following contract is optimal*:

1) *Type* $(l,l) : \beta(l,l) = 0$ *and* $R^1(l,l) = 2\pi_l$.

2) *Type* $(h,l) : \beta(h,l) = 1/[2(1-p)]$, $R^1(h,l) = \pi_h + \pi_l$, *and* $R^2(h,l) = 2\pi_l$ *if* $p \leq 1/2$, *and* $\beta(h,l) = 1$, $R^1(h,l) = 2\overline{\pi}$, *and* $R^2(h,l) = 2\pi_l$ *if* $p \geq 1/2$.

3) *Type* $(h,h) : \beta(h,h) = 1$, $R^1(h,h) = 2\pi_h$, *and* $R^2(h,h) = \overline{\pi} - 2(\pi_h - \pi_l) + I$.

Proof. As in the proof of Proposition 1 we solve again a relaxed problem. The corresponding incentive compatibility constraint for type (h,h), which explicitly takes into account the possibility that type (h,h) can finance one or more second-period projects with internal funds by mimicking type (l,l), is denoted by $\bar{C}(h,h)$. Type (h,h)'s payoff from deviating and mimicking type (l,l) is then as follows:

$$U^D(h,h) := \begin{cases} 2\pi_h - R^1(l,l) + \beta(l,l)\left[2\bar{\pi} - R^2(l,l)\right] & \\ +\left[1-\beta(l,l)\right](\bar{\pi} - I) & \text{if } I \leq 2\pi_h - R^1(l,l) < 2I \\ 2\pi_h - R^1(l,l) + \beta(l,l)\left[2\bar{\pi} - R^2(l,l)\right] & \\ +\left[1-\beta(l,l)\right]2(\bar{\pi} - I) & \text{if } 2\pi_h - R^1(l,l) \geq 2I. \end{cases}$$

Since $R^1(l,l) \leq 2\pi_l$ the case where $2\pi_h - R^1(l,l) < I$ can be safely ignored as it violates (A.3). Moreover, the first two lemmas in the proof of Proposition 1 continue to hold (with $C(h,h)$ being replaced by $\bar{C}(h,h)$). Since $\beta(l,l) = 0$ and $R^1(l,l) = 2\pi_l$, (A.3) implies that $U^D(h,h) = 2(\pi_h - \pi_l) + \bar{\pi} - I$. Similar to the proof of the first lemma in the proof of Proposition 1, the investor's objective function can the be rewritten as

$$-2(\pi_l - I) + 2p(1-p)\beta(h,l)2(\bar{\pi} - I) + (1-p)^2(2\beta(h,h) - 1)(\bar{\pi} - I). \tag{16}$$

Given that (16) is strictly increasing in both $\beta(h,l)$ and $\beta(h,h)$ the arguments in the proof of Proposition 1 extend to the current proof. In particular, the optimal contracts for types (l,l) and (h,l) are the same as in Proposition 1. Furthermore, we have that $\beta(h,h) = 1$, which, together with $\bar{C}(h,h)$, implies that $R^1(h,h) = 2\pi_h$ and $R^2(h,h) = \bar{\pi} + I - 2(\pi_h - \pi_l)$. To verify that the neglected incentive compatibility constraints hold, note that it is impossible for type (h,l) to make a repayment of $R^1(h,h) = 2\pi_h$ at date 1. Q.E.D.

Proof of Proposition 3. We first derive the joint probabilities for types (l,l), (h,l), and (h,h) for arbitrary correlation coefficients. Denote the random variables associated with the two project cash flows by X and Y, respectively. The joint probabilities are then $\omega := \Pr(x = \pi_l, y = \pi_h) = \Pr(x = \pi_h, y = \pi_l)$, $\Pr(x = y = \pi_l) = p - \omega$, and $\Pr(x = y = \pi_h) = 1 - p - \omega$. Since $\rho := Cov(X,Y)/\sigma_X\sigma_Y$ and $\sigma_X = \sigma_Y$ we have $\rho = 1 - \omega/p(1-p)$. Solving for ω we obtain the probabilities given in the text. Moreover, since $\omega \leq \min[p, 1-p]$ it follows that the correlation coefficient is bounded from below by $\underline{\rho} := 1 - (\min[p, 1-p]) / [p(1-p)]$ (this function characterizes the set of feasible (ρ, p)-combinations).

While the optimal contract under centralized borrowing is the same as that derived in the proof of Proposition 2, the investor's expected profit has changed as the probabilities for types (l, l), (h, l), and (h, h) have changed. Inserting the terms of the optimal contract in the investor's objective function while taking into account the new probabilities, we then have that the investor's expected profit equals $2(\pi_l - I) + [1 - p + p(1-\rho)(1+p)](\overline{\pi} - I)$ if $p \leq 1/2$ and $2(\pi_l - I) + [1 + 3p(1-\rho)](1-p)(\overline{\pi} - I)$ if $p \geq 1/2$. Comparing these values with the investor's expected profit under decentralized borrowing, $2(\pi_l - I) + (1-p)\,2(\overline{\pi} - I)$, we obtain the following result:

Lemma. *If (A.1) and (A.3) hold and projects are arbitrarily correlated the comparison between centralized and decentralized borrowing is as follows.*

1) $\rho \in (2/3, 1]$: *Decentralized borrowing is optimal.*

2) $\rho \in (1/3, 2/3]$: *If* $p \leq 1/[3(1-\rho)]$ *decentralized borrowing is optimal, whereas if* $p \geq 1/[3(1-\rho)]$ *centralized borrowing is optimal.*

3) $\rho \in (-1/2, 1/3]$: *If* $p \leq \overline{p}(\rho) := \left[\rho - 2 + \sqrt{8 + \rho^2 - 8\rho}\right] / [2(1-\rho)]$ *decentralized borrowing is optimal, whereas if* $p \geq \overline{p}$ *centralized borrowing is optimal.*

4) $\rho \in [-1, -1/2]$: *Centralized borrowing is optimal.*

It is easy to check that the functions $1/[3(1-\rho)]$ and $\overline{p}(\rho)$ are both strictly increasing and intersect at $\rho = 1/3$, which completes the proof. Q.E.D.

Proof of Proposition 4. The proof is analogous to that of Proposition 2. The optimal contract under decentralized borrowing is the same as in Section 2, except that $R^1(h) = \overline{\pi}_2$. The optimal contract under centralized borrowing given (A.1) & (A.3) is also the same as in Section 2, except that $R^1(h, l) = 2\overline{\pi}_2$ if $p_2 \geq 1/2$, $\beta(h, l) = 1/[2(1-p_2)]$ if $p_2 < 1/2$, and $R^2(h, h) = \overline{\pi}_2 - 2(\pi_h - \pi_l) + I$. Inserting the optimal contract in the investor's objective function, we have that under decentralized borrowing the investor invests at date 0 if and only if

$$I \leq \overline{\pi}_2 - \frac{\overline{\pi}_2 - \pi_l}{2 - p_1}.$$

By contrast, under centralized borrowing given (A.1) & (A.3) he invests at date 0 if and only if

$$I \leq \overline{\pi}_2 - \frac{\overline{\pi}_2 - \pi_l}{1 + 2(1-p_1)p_1 + \frac{(1-p_1)^2}{2}}$$

if $p_2 \geq 1/2$, and

$$I \leq \overline{\pi}_2 - \frac{\overline{\pi}_2 - \pi_l}{1 + \frac{(1-p_1)p_1}{(1-p_2)} + \frac{(1-p_1)^2}{2}}$$

if $p_2 \leq 1/2$. Comparing these expressions yields the result. Q.E.D.

Proof of Proposition 5. If $\overline{\pi}_L - \overline{\pi}_H$ is large we have that $p_L < 1/2 < p_H$. Consider first the investment threshold if either two front- or two backloaded projects are pooled. From the proof of Proposition 4 we have that

$$I \leq \pi_l + (\pi_h - \pi_l)(1 - p_H)\frac{4(1-p_L)p_L + (1-p_L)^2}{2 + 4(1-p_L)p_L + (1-p_L)^2} \tag{17}$$

if two front-loaded projects are pooled, and

$$I \leq \pi_l + (\pi_h - \pi_l)(1 - p_H)^2\frac{2p_H + (1-p_H)(1-p_L)}{2(1-p_L) + 2(1-p_H)p_H + (1-p_H)^2(1-p_L)} \tag{18}$$

if two back-loaded projects projects are pooled. As $p_H - p_L \to 1$ the spread $\overline{\pi}_L - \overline{\pi}_H = (\pi_h - \pi_l)(p_H - p_L)$ widens, and both (17) and (18) converge to π_l.

Consider next the investment threshold if one front- and one backloaded project are pooled. If $\overline{\pi}_L - \overline{\pi}_H$ is large we have that $\overline{\pi}_H < I < \overline{\pi}_L$. We first characterize the optimal contract, where we can build on arguments in the proof of Proposition 2. The contract with type (l, l) is identical to that in the proof of Proposition 2. Regarding type (h, l), we can treat the state where the frontloaded project has a high cash flow and the backloaded project has a low cash flow equivalently to the state where the backloaded project has a high cash flow and the frontloaded project has a low cash flow. Under the optimal contract the investor pays I with probability one at date 1, which ensures that the firm can continue the profitable backloaded project. The optimal repayment is $\overline{\pi}_L$ at date 1 and π_l at date 2. As for type (h, h), the investor pays again I with probability one at date 1. Due to the additional self-financing constraint, however, the investor can extract at most $2\pi_l$ at date 1 and zero at date 2. Substituting these specifications into the investor's profit function yields the investment threshold

$$I \leq \pi_l + (\pi_h - \pi_l)(1 - p_L)\frac{p_H(1-p_L) + p_L(1-p_H)}{2 + p_H(1-p_L) + p_L(1-p_H)},$$

which converges to $\pi_l + (\pi_h - \pi_l)/3 > \pi_l$ as $p_H - p_L \to 1$. Q.E.D.

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