DISCUSSION PAPER SERIES

No. 2784

CORPORATE BORROWING AND FINANCING CONSTRAINTS

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FINANCIAL ECONOMICS and INDUSTRIAL ORGANIZATION

Centre for Economic Policy Research

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ISSN 0265-8003

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Discussion Paper No. 2784
April 2001

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CEPR Discussion Paper No. 2784

April 2001

ABSTRACT

Corporate Borrowing and Financing Constraints*

This Paper adopts an optimal contracting approach to internal capital markets. We study the role of headquarters in contracting with outside investors, with a focus on whether headquarters eases or amplifies financing constraints compared to decentralized firms where individual project managers borrow separately. If projects differ in their ex post cash-flows, headquarters makes greater repayments to investors than decentralized firms, which eases financing constraints. Effectively, headquarters then subsidizes low-return projects with high-return projects' cash. On the other hand, headquarters may, by pooling cash flows and accumulating internal funds, make investments without having to return to the capital market. Without any capital market discipline, however, it is harder for outside investors to force the firm to disgorge funds, which tightens financing constraints ex ante. Both the costs and benefits of internal capital markets are endogenous and arise as part of an optimal financial contract. Our results are consistent with empirical findings showing that conglomerate firms trade at a discount relative to a comparable portfolio of stand-alone firms.

JEL Classification: D32, G31, G32, G34
Keywords: diversification discount, internal capital markets, theory of the firm

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* We are particularly indebted to Patrick Bolton whose insightful comments greatly improved the Paper. In addition, we wish to thank Mike Burkart, Bhagwan Chowdhry, James Dow, Zsuzsanna Fluck, Martin Hellwig, Thomas Mariotti, Alan Morrison, Rafael Repullo, Per Strömberg, Steve Tadelis, Elu von Thadden, Jeff Zwiebel, and seminar participants at Berkeley, Frankfurt, Lausanne, LSE, Mannheim, Princeton, Saarbrücken, Stanford, the Stockholm School of Economics, the European Summer Symposium in Economic Theory (ESSET) in Gerzensee (2000), the European Summer Symposium in Financial Markets (ESSFM) in Gerzensee (2000), and the TMR Meeting on Financial Market Efficiency, Corporate Finance and Regulation in Barcelona (2000) for their helpful comments and suggestions. This is a completely revised version of an earlier paper entitled 'Project Bundling, Liquidity Spillovers, and Capital Market Discipline'. Financial support from Deutsche Forschungsgemeinschaft, Sonderforschungsbereich 504, is gratefully acknowledged. This Paper is produced as part of a CEPR research network on 'Product Markets, Financial Markets and the Pace of Innovation in Europe', funded by the European Commission under the Research Training Network Programme (Contract No: HPRN-CT-2000-00061).

Submitted 13 December 2000

NON-TECHNICAL SUMMARY

There is a large macroeconomic literature documenting that the investment behaviour of firms is affected by firm-wide financing constraints (see Hubbard, 1998 for a discussion and overview). As for micro-level foundations, it is generally assumed that these financing constraints are caused by capital market imperfections such as moral hazard or asymmetric information. Given the importance of the problem, it is surprising that only a little theoretical work has been done on the implications of financing constraints for firm policy other than investment behaviour. A notable exception is the capital structure literature where it has been shown that the presence of capital market imperfections may affect the firm's choice of financing instruments (e.g. Myers and Majluf 1984). Due to the stylized nature of these models, however, it is difficult to draw implications for other aspects of firm policy such as e.g. organizational structure.

Some clues as to how financing constraints may affect organizational structure is found in the recent literature on internal capital markets. There, it is shown that centralized organizations where headquarters controls the flow of funds to, and from, individual projects may face different financing constraints than decentralized organizations. For instance, in Stein (1997) headquarters has a natural advantage in assigning cash flow to high yield uses (Stein refers to this as 'winner-picking'). Headquarters may therefore be able to raise more money from outside investors than individual project managers if they were to raise finance separately. Conversely, in Gertner, Scharfstein and Stein (1994) the fact that headquarters has control rights may weaken project managers' incentives and hence lower the projects' (continuation) value, which leads to a tightening of the credit constraint. In both cases, however, the costs and benefits of headquarters obtain even if the firm's credit constraint is unchanged. This is most clearly seen in Stein (1997), where in the first part of his model he shows that headquarters may create value (through winner-picking) while holding the credit constraint fixed. In a second, separate, part he then argues that this value creation should naturally also lead to a relaxation of the credit constraint.

In this Paper we present a model where the choice of organizational structure follows directly from considerations to ease firm-wide financing constraints. Other than that, headquarters creates (or destroys) no value. Moreover, unlike existing Papers on internal capital markets we adopt an optimal contracting approach. The agency problem that we consider is strategic default as examined in, e.g. Bolton and Scharfstein (1990, 1996) and Hart and Moore (1998). With strategic default, credit constraints arise endogenously from the need to provide firms with incentives to fulfil their payment obligations. This leads to two types of inefficiencies. First, some positive net present value investments are not undertaken. Second, while positive net present value

investments may be undertaken initially, they are not refinanced later even though refinancing would be strictly efficient.

We show that centralized borrowing, where headquarters borrows on the projects' behalf and against their combined cash flows, may alleviate both types of inefficiencies. The result rests critically on a distinction made in the internal capital markets literature that under centralized borrowing headquarters has control rights, whereas under decentralized borrowing individual project managers have control rights (Stein 1997, 2000; Gertner, Stein and Scharfstein, 1994; Matsusaka and Nanda, 2000). By virtue of its control rights, headquarters can withdraw from individual projects whatever cash flow it needs to repay firm debt. In doing so, headquarters effectively solves an externality problem with respect to debt repayment that would exist if the individual project managers had control rights and were to borrow separately.

There is also a dark side to centralized borrowing, which is closely linked to the problem of strategic default. If financial contracting is incomplete, the only way to prevent borrowers from defaulting may be to threaten to withhold financing in the future. By pooling cash flows from individual projects, however, headquarters may overcome investment indivisibilities and invest in follow-up projects without having to return to the capital market. Without any disciplinary pressure from the capital market, headquarters can make investments that benefits the firm, but not outside investors. Centralized borrowing thus makes it harder for outside investors to force firms to pay out funds and may lead to a tightening of the credit constraint. By contrast, individual project managers may not have enough funds to overcome indivisibilities, which implies that they must necessarily go back to the capital market.

The problem is reminiscent of Jensen's (1986) free cash flow problem, with the difference that we explicitly model how internal cash flow is accumulated over time. The end result is similar, however, viz. that it is harder for outside investors to force firms to disgorge funds and expose them to capital market pressure if the firms have plenty of internal cash flow. In this connection, Jensen (1986, 1989) argues that an increase in leverage may be beneficial as it enables firms to effectively bond their promise to pay out future cash flow. In our model debt *is* an optimal contract and yet, the problem persists, since the more debt is raised the greater is also the incentive not to repay the debt. In other words, the same capital market imperfection that makes debt attractive also limits the amount of debt that can be raised.

Our model has implications for the current debate about the diversification discount, i.e. the observation that conglomerate firms trade at a discount relative to a portfolio of stand-alone firms operating in the same business segments (as measured by two-digit SIC codes). Except for extreme parameter values where either only centralized or decentralized borrowing is optimal, our results suggest that projects with a low expected return should be grouped together in a conglomerate where headquarters borrows on the projects' behalf and against their combined cash flows. Conversely, projects with a high expected return should be decentralized, loosening ties as much as possible, with no common internal capital market (like a typical holding company), or what is equivalent from the perspective of the model, operating as stand-alone firms. Cross-sectionally, this implies that conglomerates should *on average* trade at a discount relative to a portfolio of stand-alone firms with similar risk characteristics. The diversification discount may thus be consistent with optimal, efficient behaviour and need not necessarily be the consequence of rent-seeking or empire-building, as is often suggested.

1 Introduction

There is ample empirical evidence that the investment behavior of firms is affected by financing constraints.[1] While there appears to be a consesus that financing constraints are caused by capital market imperfections such as moral hazard or asymmetric information, relatively little is known about the extent to which financing constraints depend on organizational choice variables such as the allocation of authority or the degree of centralization within an organization. One reason for this is that financial contracting models, while deriving financing constraints and the associated underinvestment problem from first principles, primarily consider settings where an investor provides finance for a single-project entrepreneur.[2]

This raises several questions. Are centralized firms where headquarters contracts with outside investors able to write "better", i.e., more efficient, financial contracts than decentralized or stand-alone firms? What exactly is the role of internal capital markets for financial contracting? And how does this affect financing constraints? The importance of these questions cannot be overemphasized. Financing constraints play an important role for the credit channel and monetary policy. If internal capital markets were to either amplify or alleviate financing constraints, this would have real consequences for the way in which macroeconomic shocks translate into business lending, and thus for the stability of production and economic growth.[3]

Hints on the possible role which headquarters may play for financing constraints are found in the recent literature on internal capital markets. There, headquarters adds or destroys value inside the firm, e.g., by engaging in winner-picking (Stein 1997), by redeploying assets across divisions (Gertner, Stein, and Scharfstein 1994), by affecting division managers' incentives (Gertner, Stein, and Scharfstein 1994; Stein 2000), or by using superior capital budgeting schemes (Berkovitch, Israel, and Tolkowsky 2000). Naturally this value creation or destruction ultimately affects the return to capital and hence also financing constraints. As none of these papers adopts a security design approach where the optimal financial contract between headquarters and outside investors is derived from first principles, however, the precise nature and magnitude of the effects

[1] See Hubbard (1998) for a discussion and overview of the literature.

[2] E.g., Bolton and Scharfstein (1990); Hart and Moore (1994; 1998).

[3] See Bernanke and Gertler (1995) for an overview of the workings of the credit channel. Papers discussing the macroeconomic implications of financing constraints are, e.g., Bernanke and Gertler (1989), Aghion, Banerjee, and Piketty (1999), and Kyotaki and Moore (1997).

remain unclear.[4]

This paper connects the literature on internal capital markets with that on optimal financial contracting. We compare financial contracting between i) outside investors and individual project managers (*decentralized borrowing*) and ii) outside investors and headquarters, which borrows on the projects' behalf and subsequently allocates the funds on the firm's internal capital market (*centralized borrowing*).[5] Decentralized borrowing is meant to represent the situation of a typical stand-alone firm or holding company where the various firms are only loosely connected.[6] By contrast, centralized borrowing is meant to represent the situation of a typical conglomerate.

Financing constraints arise endogenously in our model as we assume that part of the projects' cash flow is nonverifiable. The question then is how the financial contract should be structured to give the firm (i.e., project managers or headquarters, depending on which scenario is considered) adequate incentives to pay back funds to investors rather than to divert them. To isolate the costs and benefits of internal capital markets arising in connection with financial contracting from other potential costs and benefits we assume that headquarters creates or destroys no value per se, i.e., there is no winner-picking or other previously studied cost or benefit in our model.

On the benefit side, headquarters solves an externality problem that would arise if the project managers were to borrow separately. If projects' ex post cash flows differ, headquarters effectively subsidizes low-return projects with high-return projects' cash. This

[4]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 cash flows (i.e., financial contracts in the literal sense) are not considered. Finally, Gertner, Stein, and Scharfstein (1994) consider optimal contracting, 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". In other words, under the internal capital market scenario headquarters and the investor are the same person. The possibility that headquarters itself may have to raise funds from outside investors, which is the central theme in our paper, is not explored.

[5]The term "borrowing" is used for expositional convenience only. As we adopt an optimal contracting approach we make no a priori restriction on the type of security issued.

[6]What matters from the perspective of the model is that the firms i) raise finance separately and ii) are not linked through a common internal capital market. In the case of "tracking stocks" the second condition may or may not hold (Zuta 1999). A good example is the Daimler-Benz holding in the 1980s. Most of the firms belonging the holding (Mercedes-Benz, AEG, MTU,...) were separately traded on the German stock exchange, and there was no common internal capital market connecting them.

permits centralized firms to make greater repayments to investors, which in turn eases financing constraints. This cross-subsidization is similar to Stein (1997) and Gertner, Stein, and Scharfstein (1994), where headquarters redeploys resources (cash or assets) from poorly performing projects to well-performing projects. The basic difference is that in our model cross-subsidization creates value *only* insofar as it allows headquarters to write more efficient contracts with outside investors. While reminiscent of Diamond's (1984) intermediation argument, a Diamond-type intermediary cannot perform the same function as headquarters as it lacks the necessary control rights.

On the cost side, headquarters may bundle different project cash flows, thereby accumulating internal cash, and make follow-up investments without having to return to the capital market. Absent any capital market discipline, however, it is harder for outside investors to force the firm to pay out funds, which tightens financing constraints ex ante. This point is reminiscent of Jensen's (1986) free cash flow-argument where it is also harder for outside investors to force firms sitting on a large pile of internally generated cash to disgorge funds. The basic difference is that in our model we take an ex ante perspective. Anticipating that such a situation may arise in the future, investors are reluctant to provide financing in the first place.

Connecting the costs and benefits allows us to trace out the boundaries of the firm. As the costs and benefits arise in different states of nature (the benefits arise in intermediate cash-flow states while the costs arise in high cash-flow states), the question as to whether centralized borrowing is optimal depends on the ex ante distribution of cash flows. Holding everything else fixed, centralization (or integration) is optimal for projects with a high expected return while decentralization (or non-integration) is optimal for projects with a low expected return. Cross-sectionally, this implies that conglomerates should *on average* trade at a discount relative to a comparable portfolio of stand-alone firms, which is consistent with the empirical evidence. While this is not the first, or only, model generating these implications, it is the first model showing that the diversification discount may persist even under optimal financial contracting.[7]

The rest of the paper is organized as follows. Section 2 presents the model and derives the costs and benefits of internal capital markets using an optimal financial contracting approach. In particular, it derives conditions under which either centralized or decentralized borrowing is optimal, which allows us to trace out the boundaries of

[7] Other models showing that conglomerates may trade at a discount are, e.g., Berkovitch, Israel, and Tolkowsky (2000), Fluck and Lynch (1999), Rajan, Servaes, and Zingales (2000), and Scharfstein and Stein (2000).

the firm. Section 3 extends the model to arbitrary correlation coefficients, discusses robustness issues, derives empirical implications, and discusses related literature. Section 4 concludes. All proofs are provided in the Appendix.

2 Centralized vs Decentralized Borrowing

The model is a multi-period contracting model with partially non-verifiable cash flows, as in, e.g., Bolton and Scharfstein (1990), DeMarzo and Fishman (2000), Gertner, Stein, and Scharfstein (1994), or Hart and Moore (1998). While much of the basic formulation here follows Bolton and Scharfstein (1990) none of the results depend on the specific context. In particular, we will show in Section 3.1 how the same results may be derived in a Hart-Moore (1998) type setting.

Suppose a project lasts for two periods. In each period it requires an investment outlay $I > 0$ and yields an end-of-period return $\pi_l < I$ with probability $p > 0$ and $\pi_h > I$ with probability $1 - p$, where $\pi_h > \pi_l$. Project returns are uncorrelated across periods. Instead of assuming that the 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 return 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 shall assume that in any given period the returns are uncorrelated. This assumption will be relaxed in Section 3.2 where we introduce arbitrary correlation coefficients. As the firm's founder has no wealth he must seek funding from outside investors. For convenience, we shall assume that there is a single investor who makes a take-it-or-leave-it offer which the firm accepts if the contract provides nonnegative expected value. While the assumption that there is a monopolistic investor may seem unrealistic it is inconsequential for our results. In fact, the only reason for making this assumption is that it considerably simplifies the contracting problem. Section 3.4 discusses how our results extend to competitive credit markets.

The firm's founder can choose between two organizational structures which differ in terms of their allocation of authority: centralized borrowing (CB) and decentralized borrowing (DB). The term "borrowing" is for expositional convenience only and is not meant to impose any a priori restriction on the optimal financial contract. Under CB a single party is in charge of both projects while under DB a different party is in charge of each project. We shall label these parties *headquarters* (CB) and *project managers* (DB), respectively. Being "in charge" of a project refers to the legal notion of i) having control rights over the project and, related to this, ii) the right to represent the project in a (financial) contract with outsiders. Hence eventually we are interested in the question of whether a single party should borrow on behalf of both projects and then allocate the funds to the projects on the internal capital market, or whether each project should borrow directly on the external capital market.[8] CB is meant to represent the situation of a typical conglomerate, whereas DB is meant to represent the situation of a stand-alone firm or holding company where the various firms raise finance separately and are not connected through a common internal capital market.[9] Finally, while the problem is framed as an organizational design problem where the founder must choose between different organizational structures and control rights allocations (as in Stein 1997), it could be alternatively framed as a divestiture problem (as in Fulghieri and Hodrick 2001) where the firm is organized as a conglomerate and the question is whether to spin off one of its divisions. The model and results are the same.

We use the standard assumption that parties in charge of projects maximize the cash proceeds from the projects under their control, e.g., because they derive private benefits that are proportional to these proceeds.[10] Financing constraints arise endogenously from the assumption that financial contracting is incomplete. In particular, we shall assume that neither project cash flows nor investment decisions are verifiable, which implies that contracts can only condition on payments between the firm and investor and public messages.[11] The assumption that cash flows are nonverifiable is standard and is meant

[8]The modelling of centralization and decentralization is identical to that in Stein (1997), except that in Stein's model there is no outside contracting while in our model there is no winner-picking. (As there is no serial correlation the two projects are identical at the beginning of each period). Although projects require no managerial effort or monitoring one may, for cosmetic purposes, add project managers who "run" the projects under CB. As in Stein's model this is inconsequential since headquarters has, by virtue of its control rights, the authority to take resources away from the projects (see Stein 1997, especially footnotes 6 & 7). To use Stein's felicitious language, when headquarters has authority managers are merely "passive robots" (Stein 2000). Models that study incentive problems between headquarters and project managers (but not between headquarters and outside investors) are e.g., Gertner, Stein, and Scharfstein (1994) and Stein (2000).

[9]Other examples of DB are leveraged buyout funds and industrial foundations such as Sweden's Investor AB (owned by the Wallenberg family) which controls several large Swedish industrial companies that have no common internal capital market.

[10]See, e.g., Rajan, Servaes, and Zingales (2000); Scharfstein and Stein (2000); Stein (1997, 2000).

[11]As we adopt a general message-game approach it is irrelevant whether cash flows and investment

to capture the idea that firms have great leeway to conceal profits. The assumption that investment decisions are nonverifiable simplifies the analysis considerably but is not needed. In Section 3.1 we present an alternative setting where the same results obtain and where investment decisions are verifiable. Finally, notice that even though courts cannot observe actual profits the investor can always enforce a repayment of π_l as this is the lowest possible cash flow. Hence we may alternatively assume that a fraction π_l of the cash flow is verifiable (e.g., the scrap value of a machine) and only the difference $\pi_h - \pi_l$ is nonverifiable. As $\pi_h - \pi_l$ may be small there is nothing in this model arguing that firms can necessarily hide or divert a large fraction of their cash flow.

Under both CB and DB the partial nonverifiablity of cash flows creates an incentive problem between the firm and outside investors. While under CB the problem is to induce headquarters to repay funds to the investor (rather than to divert them), the problem under DB is to induce the individual project managers to repay funds. As for CB two subcases arise, depending on whether a high-return firm can (partly) self-finance second-period production or not. We shall label these subcases "self-financing" and "no self-financing", respectively.

Decentralized Borrowing (DB)

This is our benchmark model. Under DB each of the two project managers borrows separately on the external capital market. Given that the contracting problem is the same for each manager we shall henceforth speak of *the* manager and *the* project. The standard way to tackle the 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 in the first period.
- 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 production, i.e., he pays I a second time, with

decisions are observable but nonverifiable, or whether insiders (i.e., project managers under DB or headquarters under CB) observe cash flows and investment decisions but outsiders like investors or courts do not. We may therefore equally assume that cash flows and investment decisions are privately observable.

probability $\beta(\hat{s})$. If the manager receives I he (optimally) invests in the second period.

- Date 2: Also 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.[12] Second, while it is 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 state that the second-period cash flow is low. By contrast, it *is* possible to induce the manager to truthfully announce his first-period cash flow by threatening him not to provide second-period financing. An implicit assumption herein is that, if a high-return manager claims that the first-period cash flow is low he cannot use the remaining cash to self-finance second-period production for if he could, the investor's threat to terminate financing would be worthless. The assumption for this is

(A.1) $\pi_h - \pi_l < I$.[13]

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.

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

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

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 $r(h) := \pi_h$.

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[12] As will become clear shortly, if β is restricted to be either zero or one the qualitative results remain the same but the benefits from centralization then become smaller.

[13] 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 $\pi_h > \overline{\pi} > I$ is violated.

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

From Bolton and Scharfstein (1990) we know that the solution to this sort of problem has $\beta(l) = 0$, $\beta(h) = 1$, $R^1(l) = R^2(h) = \pi_l$, and $R^1(h) = \overline{\pi}$. If the manager announces that the first-period cash flow is high he receives second-period funding with probability one. On the other hand, if he announces that the first-period cash flow is low he receives second-period funding with probability zero.

The optimal contract between the manager and investor involves two types of inefficiencies. First, with probability p there will be no second-period funding. But second-period funding is strictly efficient since project returns are not serially correlated.[14] Second, if we insert the terms of the optimal contract in the investor's objective function and solve for the critical value of I at which the investor 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 which 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 net present value. In other words, the firm is financially constrained.

Centralized Borrowing (CB): No Self-Financing

Under CB headquarters borrows against the projects' combined cash flows. 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 $(1-p)^2$. All assumptions as well as the sequence of events are the same as under DB. As a contract now encompasses two projects rather than one further assumptions are needed, however.

1) Without loss of generality we shall restrict attention to contracts where at date 1 the investor pays $2I$ with probability $\beta(\hat{s})$, which is the natural extension of the single

[14] Despite this inefficiency, however, there will be no renegotiation on the equilibrium path as the maximum amount that the investor can assure in the second period is $\pi_l < I$. See Section 3.3 for a more detailed discussion of renegotiation.

project case. In principle one could conceive of more general contracts where, e.g., the investor randomizes over payments of arbitrary size. As can be shown, however, extending the contracting space this way leads to exactly the same results. A formal proof of this is found in the working paper version (Inderst and Müller 2000).

2) By analogy with DB we need to specifiy what the firm's self-financing possibilities are if a high-return firm falsely claims that its cash flow is low. Given (A.1) there are only two possibilities: i) self-financing is never possible, i.e., $2(\pi_h - \pi_l) < I$, or ii) if both first-period cash flows are high headquarters can finance one (but only one) second-period project without having to return to the capital market, i.e., $2I > 2(\pi_h - \pi_l) > I$. (If headquarters could self-finance both second-period projects (A.1) would be violated).

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 a large number of projects. Still, it is useful to consider this case since there centralized borrowing has benefits but no costs, which provides us with a clear-cut characterization of the benefits of internal capital markets for financial contracting. If self-financing is possible these benefits are still present, but there are then also costs. Again, the assumption that self-financing is not possible is

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

Note that (A.2) implies (A.1), which is necessary in order to compare CB with DB.

The problem under CB is to induce headquarters to truthfully announce its cash flow. Define the set of possible cash-flows as $S := \{(l,l), (l,h), (h,h)\}$. The investor solves

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

s.t.

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

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

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 is again omitted as it is implied by the stronger limited liability constraints (6)-(7).

The optimal contract is derived in the Appendix. For the firm with the highest and lowest first-period cash flow the optimal contract is the same as under DB, 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 $R^2(h,h) = 2\pi_l$. Hence if both first-period cash flows are low the firm receives no second-period funding whereas if both first-period cash flows are high the firm receives second-period funding with probability one. In the intermediate state where one cash flow is low and the other is high the optimal contract is either identical to that of a high-return firm (if $p \geq 1/2$), or it has $\beta(h,l) = 1/[2(1-p)]$, $R^1(h,l) = \pi_h + \pi_l$, and $R^2(h,l) = 2\pi_l$ (if $p < 1/2$). To interpret this result we take a step back and reconsider the optimal contract under decentralized borrowing.

Under DB the outcome if one cash flow is low and the other is high is that the low-return firm obtains no second-period funding whereas the high-return firm obtains second-period funding with probability one. The low-return firm is not refinanced due to a liquidity shortage. As the investor incurs a loss of $\pi_l - I$ in the second period he is only willing to finance second-period production if in return he receives a date 1-repayment which is greater than the verifiable cash flow component π_l. Accordingly, as the low-return firm's cash flow is only π_l it is not refinanced. By contrast, the high-return firm has spare cash equal to $\pi_h - \pi_l$ (*after* making its date-1 repayment), which is the information earned from telling the truth. If the high-return firm were somehow to share this excess liquidity with the low-return firm, the latter could make a greater first-period repayment and in return receive second-period funding with positive probability.[15] But as each manager cares only about his own project's cash flow such welfare-enhancing cross-subsidization does not occur.[16]

Under CB it is the projects' combined cash flow that matters for repayment pur-

[15]Unlike standard adverse selection models incentive compatibility in this model does not require a distortion of the refinancing probability. The reason is that there is no serial correlation across projects, i.e., whether a project has a high or low cash flow in the first period has no relevance for the second-period cash flow. Formally, this implies that the payoffs do not exhibit the usual (strong) single-crossing property (see Faure-Grimaud and Mariotti 1999).

[16]An important question is whether at date 0 the two firms can write an insurance contract stipulating that if one firm has a high and the other a low cash flow the high-return firm must cross-subsidize the low-return firm. The answer is no. If the high-return firm had to share part of its information rent with the low-return firm the former would have no incentive to reveal its true cash flow in the first place as all incentive constraints under the optimal contract are binding.

poses and not how this cash flow is divided across projects. As headquarters cares only about total firm cash flow the above externality problem does not arise. Effectively, headquarters then subsidizes the low-return project with the high-return project's cash. While reminiscent of arguments in Stein (1997, 2000) and Gertner, Stein, and Scharfstein (1994) cross-subsidization here creates no value per se as both projects have the same expected cash flow at the beginning of each period, i.e., there is no scope for winner-picking. Cross-subsidization has value only insofar as it permits centralized firms to make greater repayments than decentralized firms, which is rewarded with a greater refinancing probability and a lower ex ante financing constraint (see below).[17] Also, while reminiscent of Diamond's (1984) intermediation argument a Diamond-type intermediary cannot perform the same function as headquarters as it lacks the necessary control rights to access the project cash flows. Much like the investor under DB a Diamond-type intermediary would have to provide the firm with incentives to make repayments. The difference between headquarters and a bank is thus the same as in other models of internal capital markets.[18]

Since either $\beta(h,l) = 1$ (if $p \geq 1/2$) or $\beta(h,l) = 1/[2(1-p)] > 1/2$ (if $p < 1/2$) the refinancing probability for the intermediate firm under CB is strictly greater than 1/2. By contrast, the corresponding average refinancing probability of a high- and a low-return firm under DB is exactly 1/2. We can therefore conclude that the first type of inefficiency, viz., that second-period projects may not get refinanced, is less severe under CB. The second type of inefficiency, viz., that not all positive net present value projects are financed at date 0, is also less severe under CB. Inserting the optimal contract in the investor's objective function (4) and solving for the investment level at which the investor breaks even we have that the investor's expected profit is nonnegative if

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

if $p \leq 1/2$, and

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

if $p \geq 1/2$. Comparing these values with the corresponding value under DB, (3), shows that irrespective of p the investment level at which the investor breaks even is strictly

[17] Repayments do not differ because information rents have changed. In fact, the combined information rent for the low- and high-return firm under DB is exactly the same as that for the intermediate firm under CB, viz., $\pi_h - \pi_l$. In the two other cash-flow states information rents are naturally the same as the optimal contracts under DB and CB are identical.

[18] E.g., Gertner, Stein, and Scharfstein (1994); Stein (1997, 2000).

greater under CB. Hence centralization of borrowing also relaxes ex ante financing constraints. This is summarized in the following proposition.

Proposition 1. *Given (A.1)-(A.2) centralized borrowing is optimal, i.e., it is better to give headquarters authority over both projects and have it borrow on the projects' behalf rather than give each manager authority over a single project and have the managers borrow separately on the external capital market.*

While the "no self-financing" case is useful as it allows us to study the benefits of internal capital markets in isolation, it is unlikely to be the relevant case if the firm has a large number of projects. To see this, consider (A.2) and increase the number of projects from two to n while holding everything else fixed. Clearly, for some finite value of n the inequality must necessarily be reversed. In other words, the more projects there are under the same roof the greater is also the likelihood that at least one second-period project can be financed without returning to the capital market. We thus come to the more realistic case where partial self-financing is possible under CB. While the benefits derived above remain there are now also costs.

Centralized Borrowing (CB): Self-Financing

Self-financing means that by pooling the cash flows from two high-return projects headquarters can overcome investment indivisibilities and finance one second-period project without having to return to the capital market. We replace (A.2) by

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

Again, (A.3) implies (A.1), which is necessary in order to compare CB with DB.

If a high-return firm falsely claims that its cash flow is low the maximum date-1 repayment that the investor can extract is $2\pi_l$. If self-financing is not possible a deviating firm's profit is therefore $2(\pi_h - \pi_l)$. On the other hand, if self-financing is possible a deviating firm's profit is $2(\pi_h - \pi_l) + \overline{\pi} - I$, as only the firm, but not the investor benefits from the additional investment. To induce the high-return firm to reveal its cash flow the investor must now additionally compensate the firm for the foregone profit of $\overline{\pi} - I$, which implies that his own profit will be reduced by the same amount. The more general idea is that, by pooling cash flows from different projects centralized firms may accumulate internal cash and make investments without having to return to the capital market. Absent any capital market discipline, however, firms can spend resources in ways that benefit them but not their original outside investors. It is then much harder for investors to force the firms to disgorge funds; in the present case the investor must raise the high-return firm's information rent by $\overline{\pi} - I$. This is reminiscent of Jensen's (1986) free cash-flow argument where it is also harder for outside investors to discipline firms that have accumulated large amounts of internal cash flow. The difference is that in this paper we adopt an ex ante perspective. If investors anticipate that free cash-flow problems may arise in the future they are reluctant to provide financing in the first place and tighten financing constraints.

Compared to the case where self-financing is not possible the investor's expected profit is reduced by $(1-p)^2 [\overline{\pi} - I]$. Hence, if p is sufficiently low this means that the investor's expected profit may be lower than under DB. Solving the investor's expected profit for the investment level at which he breaks even we then have that the investor's expected profit is nonnegative if

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

if $p \leq 1/2$, and

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

if $p \geq 1/2$. Comparing these values with the corresponding value under DB, (3), we obtain the following proposition.

Proposition 2. *Given (A.1) & (A.3) centralized borrowing where headquarters has authority over both projects and borrows on the projects' behalf is optimal if* $p \geq \sqrt{2} - 1$. *Conversely, if* $p \leq \sqrt{2} - 1$ *it is optimal to give each manager authority over a single project and have the managers borrow separately on the external capital market.*

If the joint probability that both cash flows are high is large, which corresponds to the probabilility of the bad state p being small, it is likely from an ex ante perspective that free cash-flow problems will arise. Anticipating this, investors respond by tightening financing constraints. If the associated inefficiency is sufficiently great the firm may be better off decentralizing or, what is conceptually equivalent, disintegrating. As a single-project firm does not generate enough cash flow to self-finance second-period production it must necessarily return to the capital market. Hence decentralization acts as a commitment vis-á-vis outside investors to stay on a tight leash.[19] The notion

[19]Whether the firm disintegrates or decentralizes, the two projects will become separate firms (recall the definition of decentralization). Hence if both cash flows are high there is a natural incentive for

that firms may benefit from (credibly committing to) a policy of regularly revisiting the capital market is not new and has been used as an explanation for why firms pay dividends (Easterbrook 1984) or issue debt (Grossman and Hart 1982; Jensen 1986). In showing that decentralization or disintegration forces firms to revisit the capital market our argument complements these existing arguments.

The benefits of internal capital markets are greater repayments to investors in intermediate states of nature due to the cross-subsidization of low-return projects with high-return projects' cash flow. The costs are free cash-flow problems in high states of nature, where the ability to pool cash flows reduces the firm's need to return to the capital market. Trading off these costs and benefits Proposition 2 traces out the boundaries of the firm. As the costs and benefits arise in different states of nature these boundaries depend on the ex ante distribution of cash flows. In particular, decentralization is optimal if high cash-flow states are more likely whereas centralization is optimal if intermediate cash-flow states are more likely.

Due to the nonverifiability of cash flows and investment decisions the investor cannot contractually force the firm to return to the capital market. 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 may be less realistic in other cases. Below we show that the assumption of nonverifiability of investment decisions is not needed if the parties can renegotiate after default.

3 General Discussion

3.1 Nonverifiability of Investment Decisions

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 we assume that the asset corresponds to the verifiable component of the project output. The investor then has the choice between selling the asset on the market for its liquidation value or renegotiating ownership of the asset (with headquarters or project

the firms to re-merge at date 1, which would undermine the commitment power of decentralization. To commit not to merge again the two firms may write a covenant into their debt contracts restricting merger activity. Such restrictions 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.

managers, depending on which scenario is considered). If the investor liquidates the asset he receives π_l. If he sells the asset back to the firm he receives P.

If the asset is sold back to the firm it may be used for another period where it generates a nonverifiable return of $\pi_l + \Delta$. We shall assume that $\Delta > 0$, i.e., the asset is worth more to the firm than to the investor. After the asset is used a second time its liquidation value is zero, i.e., there is full depreciation. Clearly, as $\Delta > 0$ liquidation is inefficient. However, as Hart and Moore (1998) point out the firm may not have sufficient 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 decentralized, or stand-alone, firms has sufficient funds to buy back the asset. However, the centralized firm, after earning $2\pi_h$ but claiming that cash flows are $2\pi_l$, does have the funds to buy back the asset. Depending on both the distribution of bargaining power and the firm's liquidity the centralized firm then makes a net gain of $\pi_l + \Delta - P \geq 0$.[20] In a renegotiation-proof contract the investor would thus have to leave a high-return firm under CB with a greater rent than the two high-return firms under DB together, which is all that is needed for Proposition 2 to obtain (the p-threshold may then be different). Hence even though investment decisions are verifiable (the use of the asset in the second period is observable), centralization lowers the investor's profit in high cash flow-states, exactly like in the previous setting.

3.2 Correlated Projects

In this section we shall consider arbitrary correlation coefficients across projects in any given period while retaining the assumption that projects are serially uncorrelated. Except for extreme correlation coefficients, in which case either CB or DB is optimal, the same picture as before emerges: if self-financing is not possible CB is optimal whereas if self-financing is possible there exists a critical threshold $\overline{p} \in (0, 1)$ such that CB is optimal if $p \geq \overline{p}$ and DB is optimal if $p \leq \overline{p}$.

Denote the correlation coefficient by ρ. While the optimal financial contract under both self-financing and "no self-financing" remains the same as before, allowing for non-zero correlation changes the projects' joint probabilities and hence the investor's

[20] The inequality may be strict even if the investor has all the bargaining power in the renegotiation game. For instance, suppose $2(\pi_h - \pi_l) = \pi_l + \Delta/2$. In this case, no matter what the investor's bargaining power is, he can capture at most half of the surplus since $\pi_l + \Delta/2$ is the most which headquarters can pay.

expected payoff.[21] The new joint probabilities are $p\left[1-(1-\rho)(1-p)\right]$ for type (l,l), $2(1-\rho)p(1-p)$ for type (l,h), and $(1-p)\left[1-p(1-\rho)\right]$ for type (h,h). (See the Appendix for a derivation of these probabilities).

We can again compute the investor's expected profit under both self-financing and "no self-financing" and compare the value with the corresponding value under DB. For "no self-financing" the result is obvious. Since centralization has only benefits CB is strictly optimal except when projects are perfectly positively correlated, in which case CB and DB are revenue-equivalent. The reason is that with perfect positive correlation the probability of reaching the intermediate state of nature where one cash flow is high and the other is low is zero. But this is the only state of nature where the benefits of internal capital markets materialize. For the case of self-financing the result is stated in the following proposition.

Proposition 3. *Given (A.1) & (A.3) and arbitrary correlation coefficients, 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* $p \geq \overline{p}(\rho)$.

Proposition 3 has a natural interpretation. As argued above, for high values of ρ the expected benefits from centralization are small. By contrast, the joint probability that both projects have a high cash flow, in which case free cash-flow problems arise, is strictly increasing in ρ. Together, this implies that for sufficiently high ρ the costs of centralization outweigh the benefits. The case of strongly negatively correlated projects is the opposite.[22] For all intermediate values of ρ both the results and the intuition carry over from Section 2. While neither organizational form dominates the other for all p, there exists an interior threshold $\overline{p}(\rho)$ such that CB is optimal if $p \geq \overline{p}(\rho)$ and DB is optimal if $p \leq \overline{p}(\rho)$. The ready may verifiy from the equation characterizing $\overline{p}(\rho)$ in the Appendix that $\overline{p}(0) = \sqrt{2}-1$, as stated in Proposition 2.

[21] The optimal contract remains unchanged because incentive compatibility and limited liability are both ex post constraints that do not depend on the ex ante joint probabilities.

[22] For negative correlation coefficients only certain combinations of ρ and p are feasible, which is an artefact of the two-point distribution. In the Appendix we provide an exact formula characterizing the set of feasible (ρ, p)-combinations.

3.3 Renegotiation

While the optimal contracts under DB and CB entail ex post inefficiencies there will be no renegotiation on the equilibrium path as a low-return firm, after making its date-1 repayment, has no funds left to compensate the investor for his second-period loss of $\pi_l - I$ per project. The situation is different if a high-return firm falsely claims that its cash flow is low. Consider, for instance, the situation under DB where such a firm has liquid funds of $\pi_h - \pi_l$. While this is not enough to finance second-period production the firm may renegotiate with the investor and ask for an additional cash injection of π_l. As the investor can assure a repayment of π_l at date 2 he will provide the money. The firm's payoff from mimicking a low-return firm is then strictly greater than $\pi_h - \pi_l$, which implies that the previously derived above is not renegotiation-proof. A similar reasoning holds for the optimal contract under CB. It is straightforward to extend the previous analysis by adding renegotiation-proofness constraints. Formal results are found in the working paper version (Inderst and Müller 2000). At this point we shall only note that all results continue to hold provided the investor has sufficient bargaining power in the renegotiation game.[23]

3.4 Competitive Credit Markets

An immediate consequence of introducing (perfectly) competitive credit markets is that more projects will be refinanced at date 1. For instance, the refinancing probability of a low-return firm under DB under the optimal financial contract is then $\beta(l) > 0$ instead of zero as before. As all results in this paper depend in some way on a comparison with this benchmark they lose much of their simplicity, which is why we assume that there is a single investor. Besides, however, all qualitative statements as well as the arguments in favor and against centralization remain the same – provided a seniority rule is added to the contract. The need for a seniority rule emerges if a high-return firm defaults and approaches another investor. Much like above under renegotiation the firm needs at most π_l to finance second-period production. As the new investor is willing to provide the money the original investor will make a loss. To avoid the problem the original parties to the contract may add a provision stating that whenever the firm defaults it cannot make payments to a new investor unless it first settles its debt with the original

[23] If the firm has all the bargaining power in the renegotiation game the investor's payoff per project is $-F + \pi_l < 0$. Hence financing breaks down completely, much like the case when there is only a single period.

investor. As payments to and from investors are verifiable, this provision is enforceable.

3.5 Empirical Implications

The main empirical implication emerging from Propositions 2 and 3 is that, *ceteris paribus*, conglomerates with well-functioning internal capital markets should have a lower *average* performance (higher p), or productivity, than stand-alone firms or holding companies where the different firms are financially autonomous. While empirical evidence on the relation between performance and the degree of diversification is scarce, Hyland (1999) and Maksimovic and Phillips (2000) both find that diversifying firms are less productive and have weaker operating performance than their single-segment counterparts. On the other hand, Schoar (2000) finds that plants of diversified firms are more productive than plants of single-segment firms in the same industry.

To the extent that stock prices track productivity (see Schoar 2000 for affirmative evidence), our results also imply that, *ceteris paribus*, conglomerates should *on average* trade at a lower value than a comparable portfolio of stand-alone firms. The empirical literature documenting that conglomerates trade at a discount is huge; some of the better known papers are, e.g., Berger and Ofek (1995), Lang and Stulz (1994), and Servaes (1996). More than that, however, our paper suggests (along with a series of other papers) that the diversification discount may be the consequence of low-performing firms' *endogenous* choice to diversify.[24] Empirical evidence consistent with this view is provided by Campa and Kedia (1999) who report that diversified firms were discounted even when they operated as single-segment firms, suggesting that they performed poorly already prior to the diversification. When the authors control for the endogeneity of the diversification decision the diversification discount always drops, and often disappears completely. In a similar vein, Graham, Lemmon, and Wolf (2000) conclude that "a fair portion of the diversification discount in multisegment firms occurs because the units that make up the conglomerates would be discounted even if they operated as stand-alone firms, and not because diversification destroys value" (p.5).

In our model the costs of conglomerates are positively related to the degree to which firms can hide or divert funds as expressed by the nonverifiable fraction of cash flows $\pi_h - \pi_l$. If the amount that can be diverted is small headquarters has no choice but to return to the capital market and ask for additional funding. In our model this is

[24] Other models suggesting that low-productivity firms benefit more from diversification are, e.g., Fluck and Lynch (1999) and Maksimovic and Phillips (2000).

the case whenever $2(\pi_h - \pi_l) < I$, in which case forming a conglomerate has benefits but no costs (Proposition 2). If the amount that can be diverted increases, however, headquarters may, by pooling and accumulating internal funds, pursue investments that benefit itself but not the firm's outside investor (see the discussion preceding Proposition 3). Not surprisingly, the degree to which free cash-flow problems arise is therefore positively related to the fraction of cash flow that is nonverifiable, i.e., the cash flow that the investor cannot easily access. Empirically, this suggests that we should see less developed *internal* capital markets in countries where accounting laws make it easier to hide funds from investors, or more generally, where investor protection is weak. As in La Porta, Lopez-de-Silanes, Shleifer, and Vishny (2000) the market ultimately provides institutions restoring the balance of powers. In their paper it is the degree of ownership concentration; here it is the organizational form and the mode of incorporation.

3.6 Related Literature

This paper is, to our knowledge, the first to study optimal contracting between headquarters and outside investors. It thus links the financial contracting literature, which typically studies contracting between investors and single-project entrepreneurs, with the literature on internal capital markets. Moreover, the only way in which internal capital markets add or destroy value in this paper is by affecting the financing constraint. This further distinguishes our paper from previous work where headquarters adds or destroys value even if the financing constraint is fixed (e.g., Stein 1997).

On a different, more abstract, level the paper shows that pooling cash flows may have both benefits and costs. In intermediate cash-flow states centralized firms make greater repayments while in high cash-flow states they make lower repayments compared to decentralized firm. From an ex ante perspective there is thus a tradeoff, since both the benefits and costs arise with positive probability. (Unless, of course, projects are either perfectly positively or negatively correlated). Moreover, both the benefits and costs are endogenous and arise as part of an optimal financial contract. In this regard, our paper is related to work on financial intermediation (e.g., Diamond 1984) and finance-based models of mergers and optimal firm size (e.g., Fluck and Lynch 1999; Li and Li 1996), which build on either the benefits or costs of cash-flow pooling, or both.

As pointed our earlier, a Diamond-type intermediary cannot perform the same function as headquarters as it lacks the necessary control rights to withdraw cash flows. (It only has control *after* the firm defaults). The difference between headquarters and a bank is thus the same as in other internal capital markets models (e.g., Gertner, Stein, and Scharfstein 1994; Stein 1997, 2000). While Fluck and Lynch have a model where the benefits of cash-flow pooling arise naturally, they need to assume exogenous costs to obtain the desired tradeoff. In Li and Li's model there are either benefits or costs of cash-flow pooling, but not both. Moreover, neither paper adopts a security design approach where the optimal financial contract is derived endogenously.[25]

4 Concluding Remarks

Financial contracting models typically consider a single-project entrepreneur who raises finance from a wealthy investor. In this setting questions regarding the allocation of authority inside the firm or the role of internal capital markets cannot be addressed. On the other hand, internal capital markets models have not, at least to our knowledge, considered optimal financial contracting between headquarters and outside investors. This paper links both literatures.

We derive the optimal financial contract for both centralized firms where headquarters borrows on projects' behalf and decentralized, or stand-alone, firms where individual project managers borrow separately. Depending on the state of nature headquarters makes greater or lower repayments to investors than decentralized firms. In intermediate cash-flow states headquarters effectively cross-subsidizes low-return projects with high-return projects' cash. This allows headquarters to make greater repayments, which in turn eases financing constraints. On the other hand, in high cash-flow states headquarters may, by pooling cash flows and accumulating internal funds, make investments without having to return to the capital market. In particular, absent any capital market discipline headquarters may then make investments that benefit itself but not the firm's outside investors. Anticipating that free cash-flow problems arise, investors optimally respond by tightening financing constraints. As that the costs and benefits of internal capital markets materialize in different states of nature the boundaries of the firm depend on the ex ante distribution of cash flows.

Finally, we believe this paper yields some basic insights which may be fruitfully applied to other areas of economics. First, by showing that cash-flow pooling may strengthen a firm's ability to expropriate investors the paper is one of few papers em-

[25] As Fluck and Lynch have a dynamic model they can address issues which our model cannot address, however, i.e., why merger decisions may be reversed in the future.

phasizing the negative sides of cash-flow pooling. As other work, especially on financial intermediation, rests largely on the positive sides of cash-flow pooling (e.g., Diamond 1984), it may be worth exploring whether a similar tradeoff can be found there. Second, internal capital markets may, via their effect on the financing constraint, affect firms' strategic behavior on the product market. For instance, in Bolton and Scharfstein (1990) the presence of financing constraints creates incentives for deep-pocket firms to lower their financially constrained rivals' short-term profits, e.g., by starting a price war. As shown in this paper, grouping several financially constrained firms into a conglomerate and creating an internal capital market may reduce financing constraints, and hence competitors' incentives to prey. Third, as we briefly pointed out in the Introduction, 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. This is a point where we especially think that more work should be done.

5 Appendix

Proof of Proposition 1. It remains to derive the optimal contract under CB and "no self-financing". The rest follows from the arguments provided 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 mimick 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 $\beta(l,l) = 1$

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 $\bar{R}_i^2(l,l) \leq 2\pi_l$ it must be true that $2\bar{\pi} - \bar{R}_i^2(l,l) > 0$. 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 again $C(h,h)$, 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. *Under CB and "no self-financing" 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* $\beta(h,l) = 1$, $R^1(h,l) = 2\overline{\pi}$, *and* $R^2(h,l) = 2\pi_l$ *if* $p \geq 1/2$.

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

$$-2(\pi_l - I) + 2\pi_l + 4p(1-p)\beta(h,l)(\overline{\pi} - I) + 2(1-p)^2\beta(h,h)(\overline{\pi} - I). \quad (8)$$

By inspection (8) 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 $2\overline{\pi} \leq \pi_h + \pi_l$ 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 $2\overline{\pi} > \pi_h + \pi_l$ setting $\beta(h,l) = 1$ violates either $C(h,l)$ or the second-period limited liability constraint for type (h,l). Accordingly, we 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

$$\pi_h + \pi_l \geq R^2(h,l) + \beta(h,l)\left[2\overline{\pi} - R^2(h,l)\right]. \quad (9)$$

If $2\overline{\pi} = R^2(h,l)$ this violates $2\overline{\pi} > \pi_h + \pi_l$, contradiction. Suppose therefore that $2\overline{\pi} < R^2(h,l)$. Solving (9) for $\beta(h,l)$ we have $\beta(h,l) \geq [\pi_h + \pi_l - R^2(h,l)]/[2\overline{\pi} - R^2(h,l)]$, which is strictly greater than one since $2\overline{\pi} < R^2(h,l)$ and $2\overline{\pi} > \pi_h + \pi_l$ 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 $\beta(h,l) = [R^1(h,l) - 2\pi_l]/[2\overline{\pi} - R^2(h,l)]$. 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 $\beta(h,l) = [R^1(h,l) - 2\pi_l]/[2\overline{\pi} - R^2(h,l)]$ we then have that

$$\beta(h,l) = \frac{\pi_h - \pi_l}{2(\overline{\pi} - \pi_l)} = \frac{1}{2(1-p)}, \quad (10)$$

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 CB and "self-financing". The rest follows from the arguments in the text.

Lemma. *Under CB and "self-financing" 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* $p \le 1/2$, *and* $\beta(h,l) = 1$, $R^1(h,l) = 2\bar{\pi}$, *and* $R^2(h,l) = 2\pi_l$ *if* $p \ge 1/2$.

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

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:

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

Since $R^1(l,l) \le 2\pi_l$ 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 be rewritten as

$$-2(\pi_l - I) + 2p(1-p)\beta(h,l)2(\bar{\pi} - I) + (1-p)^2\left(2\beta(h,h) - 1\right)(\bar{\pi} - I). \tag{11}$$

Given that (11) 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 check for the neglected incentive compatibility constraints note that under this solution 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 begin by deriving 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 CB and "self-financing" is the same as that for uncorrelated projects derived in the proof of Proposition 2, the investor's expected profit is not 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 DB, $2(\pi_l - I) + (1-p) 2 (\overline{\pi} - I)$, we obtain the following result:

Lemma. *If self-financing is possible and projects are arbitrarily correlated the comparison between CB and DB is as follows.*

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

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

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

4) $\rho \in [-1, -1/2]$: *CB 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.

6 References

Aghion, P., Banerjee, A., and Piketty, T. (1999), "Dualism and Macroeconomic Volatility," Quarterly Journal of Economics 114, 1359-1397.

Berger, P.G., and Ofek, E. (1995), "Diversification's Effect on Firm Value," Journal of Financial Economics 37, 39-65.

Berkovitch, E., Israel, R., and Tolkowsky, R. (2000), "The Boundaries of the Firm: The Choice Between Stand-Alone and Integrated Firms," mimeo, Tel Aviv University.

Bernanke, B.S., and Gertler, M. (1989), "Agency Cost, Net Worth ,and Business Fluctuations," American Economic Review 79, 14-31.

Bernanke, B.S., and Gertler, M. (1995), "Inside the Black Box: The Credit Channel of Monetary Policy Transmission," Journal of Economic Perspectives 9, 27-48.

Bolton, P., and Scharfstein, D.S. (1990), "A Theory of Predation Based on Agency Problems in Financial Contracting," American Economic Review 80, 93-106.

Campa, J.M., and Kedia, S. (1999), "Explaining the Diversification Discount," mimeo, Harvard University.

DeMarzo, P.M., and Fishman, M.J. (2000), "Optimal Long-Term Financial Contracting with Privately Observed Cash Flows," mimeo, Northwestern University.

Diamond, D. (1984), "Financial Intermediation and Delegated Monitoring," Review of Economic Studies 51, 393-414.

Easterbrook, F.H. (1984), "Two Agency-Cost Explanations of Dividends," American Economic Review 74, 650-659.

Faure-Grimaud, A., and Mariotti, T. (1999), "Optimal Debt Contracts and the Single-Crossing Condition," Economics Letters 65, 85-89.

Fluck, S., and Lynch, A.W. (1999), "Why Do Firms Merge and Then Divest? A Theory of Financial Synergy," Journal of Business 72, 319-346.

Fulghieri, P., and Hodrick, L.S. (2001), "Synergies and Internal Agency Conflicts: The Double-Edged Sword of Mergers," mimeo, INSEAD.

Gertner, R.H., Scharfstein, D.S., and Stein, J.C. (1994), "Internal versus External Capital Markets," Quarterly Journal of Economics 109, 1211-1230.

Graham, J.R., Lemmon, M.L., and Wolf, J. (2000), "Does Corporate Diversification Destroy Value?" mimeo, Duke University.

Grossman, S.J., and Hart, O.D. (1982), "Corporate Financial Structure and Managerial Incentives," in: The Economics of Information and Uncertainty, ed. by J.J. McCall. Chicago: University of Chicago Press.

Hart, O.D., and Moore, J.H. (1994), "A Theory of Debt Based on the Inalienability of Human Capital," Quarterly Journal of Economics 109, 841-879.

Hart, O.D., and Moore, J.H. (1998), "Default and Renegotiation: A Dynamic Model of Debt," Quarterly Journal of Economics 113, 1-41.

Hubbard, R.G. (1998), "Capital-Market Imperfections and Investment," Journal of Economic Literature 36, 193-225.

Hyland, D.C. (1999), "Why Firms Diversify: An Empirical Examination," mimeo, University of Texas at Arlington.

Inderst, R., and Müller, H.M. (2000), "Project Bundling, Liquidity Spillovers, and Capital Market Discipline," mimeo, University of Mannheim.

Jensen, M.C. (1986), "Agency Costs of Free Cash Flow, Corporate Finance, and Takeovers," American Economic Review 76, 323-329.

Kiyotaki, N., and Moore, J. (1997), "Credit Cycles," Journal of Political Economy 105, 211-249.

Lang, L., and Stulz, R.M. (1994), "Tobin's Q, Corporate Diversification, and Firm Performance," Journal of Political Economy 102, 1248-1280.

La Porta, R., Lopez-de-Silanes, F., Shleifer, A., and Vishny, R. (2000), "Investor Protection and Corporate Governance," Journal of Financial Economics 58, 3-27.

Li, D.D., and Li, S. (1996), "A Theory of Corporate Scope and Financial Structure," Journal of Finance 51, 691-709.

Maksimovic, V., and Phillips, G. (2000), "Do Conglomerate Firms Allocate Resources Inefficiently?", mimeo, University of Maryland.

Rajan, R., Servaes, H., and Zingales, L. (2000), "The Cost of Diversity: The Diversification Discount and Inefficient Investment," Journal of Finance 55, 35-80.

Scharfstein, D.S., and Stein, J.C. (2000), "The Dark Side of Internal Capital Markets: Divisional Rent-Seeking and Inefficient Investment," Journal of Finance 55, 2537-2564.

Schoar, A.S. (2000), "Effects of Corporate Diversification on Productivity," mimeo, University of Chicago.

Servaes, H. (1996), "The Value of Diversification During the Conglomerate Merger Wave," Journal of Finance 51, 1201-1225.

Smith, C., and Warner, J.B. (1979), "On Financial Contracting: An Analysis of Bond Covenants," Journal of Financial Economics 7, 117-161.

Stein, J.C. (1997), "Internal Capital Markets and the Competition for Corporate Resources," Journal of Finance 52, 111-133.

Stein, J.C. (2000), "Information Production and Capital Allocation: Decentralized vs. Hierarchical Firms," NBER Working Paper 7705.

Zuta, S. (1999), "Diversification Discount and Targeted Stock: Theory and Empirical Evidence," mimeo, University of Maryland.