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A HEDGING PERSPECTIVE ON CORPORATE FINANCIAL POLICIES

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ABSTRACT

We model the interplay between cash and debt policies in the presence of financial constraints. While saving cash allows financially constrained firms to hedge against future income shortfalls, reducing debt - "saving borrowing capacity" - is a more effective way of securing future investment in high cash flow states. This trade-off implies that constrained firms will allocate excess cash flows into cash holdings if their hedging needs are high (i.e., if the correlation between operating cash flows and investment opportunities is low). However, constrained firms will use excess cash flows to reduce current debt if their hedging needs are low. The empirical examination of cash and debt policies of a large sample of constrained and unconstrained firms reveals evidence that is consistent with our theory. In particular, our evidence shows that financially constrained firms with high hedging needs have a strong propensity to save cash out of cash flows, while showing no propensity to reduce outstanding debt. In contrast, constrained firms with low hedging needs systematically channel free cash flows towards debt reduction, as opposed to cash savings. Our analysis points to an important hedging motive behind standard financial policies such as cash and debt management. It suggests that cash should not be viewed as negative debt.

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1 Introduction

Standard valuation models subtract the amount of cash in the firm's balance sheet from the value of outstanding debt to compute the firm's financial leverage. This practice reflects the view of cash as the "negative" of debt: because cash balances can be readily used to redeem debt (a senior claim), only net leverage should matter in gauging shareholders' (residual) wealth. The traditional valuation approach can also be understood under an "indifference" argument: since financial assets and liabilities are largely unrelated to the real business activities of nonfinancial firms, shareholders should be indifferent between one extra dollar of cash and one less dollar of debt in the balance sheet. In one way or another, the standard valuation approach does not assign much of a relevant, independent role for cash stocks in the presence of debt.

In contrast to this view, a number of recent studies argue that cash holdings are an important component of the firm's optimal financial structure. Among other results, these studies show that cash policies are empirically associated with firm value, growth opportunities, business risk, and performance. They also show that cash holdings relate to issues ranging from firms' access to the capital markets to the quality of laws protecting minority investors.[1] One interpretation of the findings in this literature is that cash should not be seen as negative debt for a large fraction of firms: cash stocks seem to play a relevant economic role. However, as Opler, Pinkowitz, Stulz, and Williamson (1999) point out, most of the variables that are empirically associated with high cash levels are also known to be associated with low leverage. The findings that cash holdings are systematically related to variables such as growth opportunities and risk — although relevant in their own right — may therefore not fully identify firms' policies toward cash and debt balances. In effect, those findings cannot rule out the argument that firms do regard cash and negative debt as substitutes. In the words of Opler et al. (p.44), "...it is important to figure out, both theoretically and empirically, to what extent cash holdings and debt are two sides of the same coin."

This paper proposes a testable theory of cash–debt substitutability in the optimal financial policy of the firm. Our starting point is the observation that, while standard valuation models assume that financing is frictionless, most real-world managers argue that raising funds in the capital markets is often "too costly" (e.g., Graham and Harvey (2001)). Arguably, contracting and information frictions indeed entail high additional costs to external financing activities. Exposure to those costs can significantly affect the way firms conduct their financial and investment policies (Almeida et al. (2004) and Faulkender and Petersen (2004)), giving rise to a "hedging motive" (cf. Froot,

[1] An incomplete list of papers in this literature includes Kim, Mauer, and Sherman (1998), Harford (1999), Opler, Pinkowitz, Stulz, and Williamson (1999), Dittmar, Mahrt-Smith, and Servaes (2003), Harford, Mikkelson, and Partch (2003), Mikkelson and Partch (2003), Pinkowitz, Stulz, and Williamson (2003), Pinkowitz and Williamson (2003), Almeida, Campello, and Weisbach (2004), Faulkender and Wang (2005), Harford, Mansi, and Maxwell (2005), and Hartzell, Titman, and Twite (2005).

Scharfstein, and Stein (1993)). Building on this argument, we develop a theoretical framework in which cash and debt policies are jointly determined within the firm's investment problem, explicitly identifying when cash is *not* the same as negative debt. By contrasting these conditions with a benchmark case in which financing is frictionless (and, hence, there is no hedging motive), we are able to assess how firms optimally carry out *both* their cash and debt policies under financial constraints.

It is easy to summarize our argument. In the absence of financing frictions, firms' future investment levels are independent of their current cash policies. Firms need not save internally to finance future profitable opportunities since all such opportunities will find financing in the capital markets. Because of this independence, and in the absence of other costs/benefits of carrying cash and debt, for financially unconstrained firms it is a matter of indifference as to whether they use their excess cash flows to increase internal savings or to reduce debt. This policy choice has no value implications.

In sharp contrast, constrained firms' financial policies can be value-enhancing. Both higher cash stocks and lower debt levels today increase a constrained firm's future funding capacity and, thus, its ability to undertake new investment opportunities. We show, however, that a trade-off guides constrained firms' choice between higher cash and lower debt. On the one hand, internal savings are useful for investment optimization when financially constrained firms experience income shortfalls. In particular, in low cash flow states, the effect of cash on investment will be *higher* than the corresponding effect of lower debt (i.e., greater borrowing capacity). On the other hand, in states in which cash flows are high, higher cash balances will have a *lower* effect on financing capacity than a corresponding reduction in outstanding debt. These key differential effects of cash and debt on future financing capacity arise from the riskiness (or the state-contingency) of the debt obligation. To wit, note that the current market value of risky debt is largely supported by future states of the world in which cash flows are high. Accordingly, reducing the amount of outstanding debt by one dollar today increases future debt capacity in *good* states by *more* than one dollar. By the same token, reducing outstanding debt by one dollar today increases future debt capacity in *bad* states by *less* than one dollar. In contrast, the marginal effect of cash on investment is invariant across states of the world: saving one additional dollar of cash today increases future financing capacity in *all* future states by *exactly* one dollar.

Our model shows that while cash holdings have a significant effect on financing capacity and investment spending in poor states of the world (low cash flow states), debt reductions are a particularly effective way of boosting investment in high cash flow states. We use this trade-off to derive testable predictions for how firms allocate free cash flows across their cash and debt accounts. In particular, we predict that a constrained firm will prefer saving cash (as opposed to reducing debt) out of current cash flow surpluses if the correlation between cash flows and investment opportunities is low, that is, if the constrained firm has "high hedging needs." In contrast, if that correlation is high ("low hedging needs"), then the firm benefits more from allocating its marginal dollar of free cash flow towards debt reductions (i.e., from "saving" future borrowing capacity).

Our analysis casts doubt on the standard view of cash as the negative of debt; a view that is commonly used in corporate valuation. Cash and (negative) debt balances are *not* close substitutes in a world where financing is not frictionless. In particular, financially constrained firms with high hedging needs strictly prefer positive cash to negative debt; a preference that has value consequences. For this type of firm, cash holdings play a significant economic role because cash allows the firm to bring future investment closer to efficient levels, which maximizes value. In contrast, constrained firms with low hedging needs value spare debt capacity; they prefer negative debt to positive cash.

Regarding unconstrained firms, our model's prediction that they should be indifferent between various combinations of cash and debt policies suggests that, for these firms, cash *could* be viewed as negative debt. However, we stress that the strict indeterminacy of cash and debt policies only holds in the absence of other costs and benefits that are unrelated to financial constraints; such as the possibility that cash has a low yield, that cash can be diverted by managers, or that debt provides for tax shields. As previous researchers have shown, such issues may very well influence corporate policies. Importantly, though, even when unconstrained firms display systematic preferences towards cash or debt, our constrained model can still be identified in the data. The reason is that unconstrained firms' choice between higher cash and lower debt today is independent of considerations about future financing capacity. The absence of a link between unconstrained firms' policies and hedging needs in turn provides us with an additional identification restriction. To wit, while constrained firms' propensity to allocate cash flows towards cash or debt should depend on the correlation between their cash flows and investment opportunities, such a dependence *should not* exist for unconstrained firms.

In the second part of the paper we evaluate the extent to which our theory's implications are borne out in the data. In doing so, we look at a large sample of manufacturing firms over a three-decade period (1971 through 2001). We estimate the simultaneous, within-firm responses of cash and debt policies to cash flow innovations for various subsamples partitioned both on (1) the likelihood that firms have constrained/unconstrained access to external capital and (2) measures of the correlation between firms' cash flows and investment opportunities ("hedging needs"). We consider four alternative firm characteristics in empirically identifying constrained and unconstrained subsamples: (1) payout policy, (2) asset size, (3) bond ratings, and (4) commercial paper ratings. To measure the correlation between cash flows and investment opportunities, we look at a *firm*'s cash flow from operations and either its *industry*-level (1) median R&D expenditures, (2) median three-years ahead sales growth rates, or (3) changes in median Q.[2] While the measures of financial constraints that we

[2] The reason for using aggregate industry-level measures of investment opportunities is that such measures are exogenous to the individual firms' internal cash flow processes. Firm-level measures, in contrast, could be contaminated by firms' ability to undertake their investment opportunities and thus by the degree of firm financing constraints.

use are quite standard, the measures of hedging needs are, to our knowledge, new to the literature.

We find robust, coherent results for debt and cash management across all of our empirical models. First, unconstrained firms do not display a propensity to save cash out of cash flows. Instead, consistent with the bulk of the capital structure literature, they use free cash flows towards reducing the amount of debt that they carry. Crucially, as predicted by our model, this pattern holds irrespective of how unconstrained firms' cash flows correlate with investment opportunities. When we then look at constrained firms, we find markedly different patterns in the way cash and debt policies are conducted. On average, constrained firms do not use excess cash flows to reduce debt, but instead prefer using those inflows to boost cash holdings. More important, we find that constrained firms' propensities to reduce debt and to increase cash are strongly influenced by the correlation between their cash flows and their investment opportunities. In other words, hedging needs seem to drive large cross-sectional differences in the optimal balance between cash and debt policies among constrained firms. To wit, when their hedging needs are low, constrained firms behave somewhat similarly to unconstrained firms: they show a propensity to use excess cash flows to reduce the amount of debt they carry into future periods, and display a relatively weaker (largely insignificant) cash flow sensitivity of cash savings. When constrained firms have high hedging needs, however, they display a strong preference for saving cash (their cash flow sensitivity of cash is positive and highly significant), while showing no propensity to reduce debt. These results are fully consistent with the predictions of our model.

Our paper is related to several strands of literature, and it is important that we establish the marginal contribution of our analysis. We have briefly discussed the literature on cash policies. The main contribution of our paper to that literature is that we model both cash and debt policies within an integrated framework. We isolate theoretically and empirically one element that affects the cash and debt policies of firms facing imperfect capital markets — namely, the inter-temporal relation between cash flows and investment opportunities — and use this wedge to identify the cash–debt policy interplay. This approach is new to the literature on corporate liquidity management.

Our paper is also related to the literature on corporate hedging. In particular, the notion that costly external finance gives rise to a hedging motive was originally developed in the influential study of Froot et al. (1993).[3] Our contribution to the hedging literature is two-fold. First, we develop and test a model that shows how firms can use both their cash and debt policies as hedging tools. As discussed by Petersen and Thiagarajan (2000), while the hedging literature has focused on the use of derivative instruments, in practice, firms use alternative means of hedging that involve

[3]We note that prior studies have proposed various alternative motivations for hedging, including tax convexity (Smith and Stulz (1985)), debt capacity and associated tax shields (Leland (1998) and Stulz (1996)), managerial risk-aversion (Stulz (1984) and Smith and Stulz (1985)), costs of financial distress (Smith and Stulz (1985)), and information issues (DeMarzo and Duffie (1991)). Empirical work testing these hypotheses includes Tufano (1996), Haushalter (2001), and Graham and Rogers (2002). See Petersen and Thiagarajan (2000) for a survey of the literature.

both financial and operating strategies. In this vein, our paper proposes that the cash–debt interplay represents a new dimension researchers can explore in examining corporate hedging. Second, we report empirical results supporting the view that financial constraints indeed create incentives for hedging. Previous attempts to test Froot et al.'s theory have focused on the use of financial derivatives and generally yielded mixed results.[4]

Our empirical approach also relates to the current capital structure literature in that we focus on companies' *marginal* financing decisions (debt issuance and repurchase activities) in order to learn about financial policy-making. Examples of recent papers that use this approach are Shyam-Sunder and Myers (1999), Frank and Goyal (2003), and Lemmon and Zender (2004). These papers are concerned with a firm's choice between debt and equity in the face of an internal "financing deficit" whose calculation takes cash holdings as exogenous. In contrast to those studies, our analysis endogenizes cash holdings, focusing on the cash versus debt margin.

Finally, our study is also related to the large literature on the impact of financial constraints on corporate policies (see Hubbard (1998) for a review). While earlier studies in that literature focused on firms' physical investments and other *real* expenditures, a few recent papers analyze the impact of constraints on firms' *financial* policies (e.g., Almeida et al. (2004) and Faulkender and Petersen (2004)). We contribute to this latter line of research by suggesting an additional financial decision that is directly affected by capital markets frictions: the choice between saving and borrowing.

The paper is organized as follows. In the next section we lay out a model of cash–debt substitutability in the presence of financing constraints and derive its empirical predictions. Section 3 describes our empirical methods and presents our main findings. Section 4 concludes the paper. Appendix A contains the proofs. Appendices B and C present extensions of our basic model.

2 The Model

We model the optimal financial policy of a firm that has profitable growth opportunities in the future but that might face limited access to external capital when funding those opportunities. In maximizing investment value, the firm's main financial policy variables are cash and debt. The admittedly simple structure of the model is meant to capture the essential elements of our theory of financial management under financing constraints.

[4]Papers with evidence that speak to the link between financial constraints and hedging include Nance, Smith, and Smithson (1993), Mian (1996), Géczy, Minton, and Schrand (1997), Gay and Nam, (1998), and Guay (1999). As discussed by Vickery (2004), the bulk of the evidence suggests that, contrary to expectations, the use of financial derivatives is concentrated in large (likely unconstrained) companies. In addition, even for large public companies the magnitude of derivatives hedging seems to be very small (see Guay and Kothari (2003)).

2.1 Structure

2.1.1 Assets and Technologies

The model has three dates. The firm starts the model at date 0 with assets in place that will produce cash flows at date 2. This cash flow c_2 is random from the perspective of date 0. At date 1, the firm learns additional information regarding c_2. With probability p, the firm gets a positive signal about c_2 (state H). In this case, the firm learns that the cash flow will be high (c_H). With probability $(1-p)$, the firm gets a negative signal (state L). In state L, there is some residual uncertainty regarding cash flows. With probability $q \in (0,1)$, c_2 equals c_H, and with probability $(1-q)$, c_2 equals $c_L < c_H$. We let $\overline{c} = [qc_H + (1-q)c_L]$ denote the expected cash flow in state L. We assume that the cash flow c_2 is produced entirely by assets that are already in place at date 0. In other words, the firm has no investment opportunity available at that initial date. In Appendix B, we introduce a date 0 investment opportunity in the model structure and show that our analysis carries over.

The firm has an existing amount of internal funds at date 0, equal to $c_0 > 0$, and a future investment opportunity that will be available at date 1. At that date, the firm can make an additional investment I, which produces output equal to $g(I)$ at date 2. Whether the firm has a profitable growth opportunity at date 1 depends on the distribution of cash flows from assets in the following way. If the firm gets a positive signal about cash flows (state H), then the firm will have an investment opportunity with probability $\phi < 1$; with probability $(1-\phi)$ there is no investment opportunity. If the firm gets a negative signal (state L), then the probability that the firm has an investment opportunity is equal to $(1-\phi)$, while with probability ϕ there is no additional investment.

In our setting, the parameter ϕ captures the correlation between cash flows from existing assets and future investment opportunities — this is in the spirit of Froot et al. (1993). When $\phi = \frac{1}{2}$, the firm has the same probability of having profitable investment in either state; that is, the correlation between cash flows and investment opportunities is zero. When $\phi > \frac{1}{2}$, that correlation is positive because the firm is more likely to have profitable investments when cash flows are high.

To simplify the analysis, we take that the uncertainty about date 2 cash flows in state L is only resolved at date 2. For the same reason, we also assume that, conditional on being in state L, the realization of the investment opportunity is uncorrelated with the date 2 realization of cash flows from assets in place. The time line of the model is presented in Figure 1.

2.1.2 Financing and Limited Pledgeability

We consider a firm run by a manager (entrepreneur) with some debt in its capital structure. The manager and the creditors are assumed to be risk-neutral. The firm starts the model with an exogenous amount of debt with face value equal to d_2. This face value is due at date 2. We consider that existing creditors cannot access the cash flows produced by the new investment opportunity,

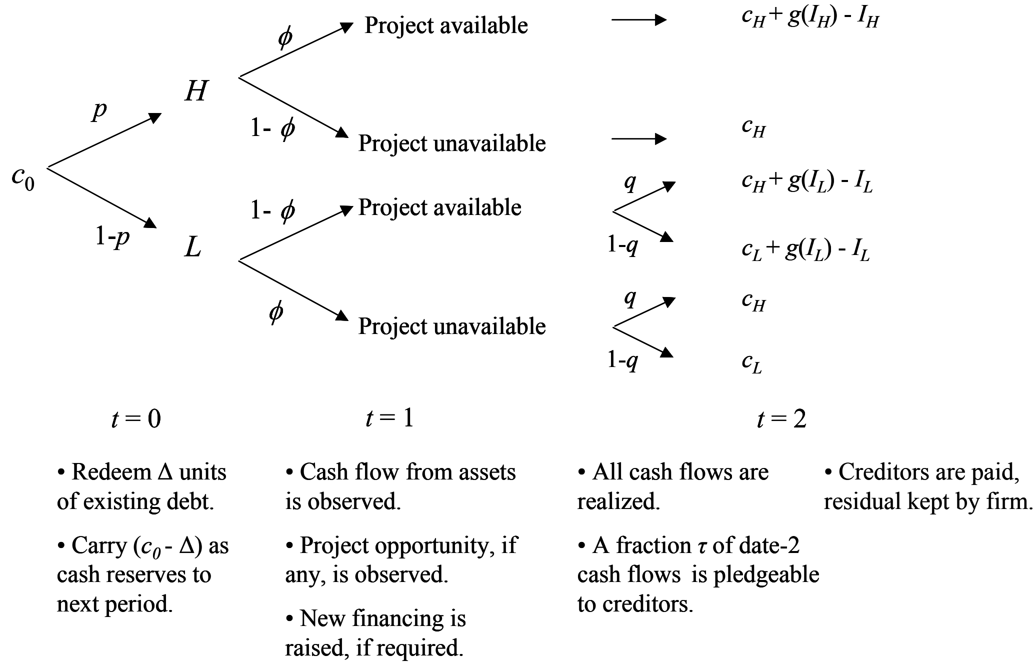

Figure 1: Basic model time line

$g(I)$. Existing debt is then backed entirely by the cash flow from assets c_2, and potentially by the cash reserves that the firm chooses to carry from date 0 into the future (see discussion below).[5] At date 0, the firm can change the amount of debt that it carries into future periods. It can either increase debt by issuing additional claims against future cash flows, or reduce debt by using current cash reserves to redeem some of its existing obligations. The amount of change in debt is captured by the parameter Δ, which can be greater than zero (debt reduction) or smaller than zero (issuance of new debt). After a debt reduction/issuance initiative, the face value of debt changes to d_2^N. We will determine below the relationship between d_2^N, Δ, and d_2.

Besides debt reduction/issuance, the firm chooses at date 0 how much cash to carry into date 1. The level of cash retained is equal to $c_1 = c_0 - \Delta$. The firm can raise new financing at date 1 backed by existing assets or by the new investment opportunity. If d_2^N is such that there is additional debt capacity from existing assets, then these assets can support more external finance. Also, the firm can raise more finance by pledging the cash flows $g(I)$. We denote the amount of new financing at date 1 by B_1. The risk-free rate is normalized to zero and all new financing is assumed to be fairly priced.

We make three assumptions concerning the pledgeability of firm's cash flows and cash reserves:

[5] The assumption that old debtholders cannot assess the cash flows from the new investment is simply meant to eliminate concerns with debt overhang (Myers (1977)). Note that because existing debt is backed by cash flows that do not depend on the payoffs of date 1 investment, at date 1 the firm has no incentives to undertake negative NPV investments that transfer value away from creditors.

Assumption I *The firm can only pledge a fraction τ of the cash flows that both the existing assets and the new investment opportunity produce.*

This limited pledgeability assumption is justified under various contracting frameworks. It arises, for example, from the inalienability of human capital (Hart and Moore (1994)). To wit, entrepreneurs cannot contractually commit never to leave the firm. This leaves open the possibility that an entrepreneur will use the threat of withdrawing his human capital to renegotiate the agreed upon payments. If the entrepreneur's human capital is essential to the project, he will get a fraction of the cash flows. Limited pledgeability is also an implication of the Holmstrom and Tirole (1997) model of moral hazard in project choice. When project choice cannot be specified contractually, investors must leave a high enough fraction of the payoff to entrepreneurs so as to induce them to choose the project with highest potential profitability.

Limited pledgeability implies that the new financing that can be raised at date 1, B_1, is capped:

$$B_1 \leq \tau g(I) + \left[\tau c_2 - d_2^N\right]^+, \tag{1}$$

where c_2 is either equal to $\overline{c}$ (state L) or c_H (state H). Because of this quantity constraint, the firm might not be able to undertake its investment opportunities to their optimal extent.

Assumption II *If the firm has an investment opportunity at date* 1*, then it can use all of its cash to invest.*

This assumption means that the firm has priority over the use of cash in case there is an investment opportunity available at date 1. We stress that this contractual feature is *optimal* in our framework: using the cash at date 1 to repay debt is a "zero NPV project," while investing the cash in the firm is positive NPV if the firm is financially constrained.

Despite the optimality of this contracting assumption within our framework, we acknowledge that in the real world debt covenants might limit investment. The possibility that existing creditors might capture a fraction of cash reserves even when the firm has positive NPV investments available will decrease firms' incentives to hold cash. However, the incentives to hold cash will only disappear if creditors *always* have strict priority over the *entire* stock of cash of the firm. This is implausible in practice. Debt covenants regarding the use of cash for investment should bind more strictly if the firm is close to default. However, in our model, the firm is not in default in state L (since $q > 0$).

The assumption that creditors cannot capture cash reserves is less tenable in states in which there is no investment opportunity. Accordingly, we assume that:

Assumption III *If the cash reserve c_1 is not employed toward investments at date* 1*, then a fraction $\tau^C \in [0,1]$ of the cash reserve can be claimed by the existing creditors in case the cash flow c_2 is not enough to repay their promised payment d_2^N.*

In analogy to the parameter τ, one can think of τ^C as measuring the pledgeability of cash stocks. In order to make our points in a parsimonious fashion, we assume for now that:

Assumption IIIA $\tau^C = 0$, *that is, creditors cannot access the firm's cash balances.*

We relax this assumption in Section 2.3.1, making it clear that our results hold irrespective of τ^C.

2.2 Solution

We solve the model backwards starting at date 1. At this date, the firm chooses optimal investment and new financing levels for given amounts of cash and debt. Then, given expected future investment choices, the firm chooses the optimal cash and debt redemption policies at date 0.

2.2.1 Date 1 Investment Choice

If there is no investment opportunity, then the firm has no relevant choice to make. For our purposes, the interesting case is the one in which the firm has an investment opportunity. In this case, the optimal date 1 behavior amounts to determining the value-maximizing investment levels, subject to the relevant budget and financing constraints. Specifically, the firm solves the following program at each relevant state of nature given Δ, d_2^N, and the realization of c_2:

$$\max_I g(I) - I \quad \text{s.t.}$$

$$I \leq c_0 - \Delta + \tau g(I) + \left[\tau c_2 - d_2^N\right]^+. \tag{2}$$

The financing available to the firm consists of (i) $c_0 - \Delta$, the cash holdings of the firm; (ii) $\tau g(I)$, the financing that can be raised against the pledgeable cash flows from the new investment opportunity; and (iii) $\left[\tau c_2 - d_2^N\right]^+$, the spare debt capacity (if any) from cash flows of the existing project.

We define I^{FB}, the first-best investment level, as:

$$g'(I^{FB}) = 1. \tag{3}$$

If the financial constraint (2) is satisfied at I^{FB}, the firm invests I^{FB}. Otherwise, it invests the value that exactly satisfies (2). In the latter case, we have $g'(I) > 1$.[6] We shall denote this constrained investment level as $I_L(\Delta)$ for state L and as $I_H(\Delta)$ for state H; where we emphasize the dependence on Δ, the debt reduction parameter. These investment levels can be used to characterize the firm financial constraints:

[6] Clearly, a necessary condition for the problem to be reasonable is that a reduction in investment relaxes the constraint, that is, $\tau g'(I) < 1$ for any I that is less than I^{FB}. Otherwise, it may be possible for the firm to self-finance the new investment opportunity and it may never be constrained — the financial constraint could be relaxed by simply increasing investment.

Definition *A firm is financially constrained if investment is below the first-best level in at least one state of nature. A firm is financially unconstrained when investment is at the first-best level in all states of nature.*

2.2.2 Date 0 Cash and Debt Policies

We now determine whether the firm is better off retaining cash or repaying debt at date 0. The date 0 financial policy can be subsumed in the optimal choice of Δ, which determines both the face value of debt d_2^N and the level of cash retained for the future, $c_1 = c_0 - \Delta$.

Market Values of Debt The first step is to determine how debt reduction, Δ, affects the face value of debt, d_2^N. We make the following assumption about the level of debt before repayment:

$$\tau c_L \leq d_2 \leq \tau c_H. \tag{4}$$

The assumption that $d_2 \leq \tau c_H$ is without loss of generality, since any amount of debt bigger than τc_H is incompatible with limited pledgeability and can thus be ignored. The lower bound on the debt level means that the initial debt of the firm is risky. That is, in state H, the firm's debt is certain to be paid off in full, but in state L, there is residual uncertainty about a full payment on debt. In state L, with probability q, the debt will be paid fully, and with remaining probability $1-q$, the debt will be in default. This uncertainty gets resolved only at date 2. Viewed from date 0 standpoint, the likelihood of no default on the firm's debt is given by $p^* = [p + (1-p)q]$.

The market value of existing debt is equal to

$$D_0 = p^* d_2 + (1-p^*) \min[\tau c_L, d_2] \geq \tau c_L. \tag{5}$$

If the firm wants to reduce its existing debt level (that is, to make $d_2^N < d_2$), it must repurchase outstanding debt that is currently held by creditors. We stress, however, that the strict need to repurchase only arises because we have assumed that the firm has no need for funds at date 0. In particular, we show in Appendix B that in a set up with date 0 investment it is not necessary to model repurchases at all. In that case, the firm chooses between issuing more or less debt at date 0, given the current and the future need for funds, and given the trade-off between cash and negative debt. Our theory's results should thus be seen as independent of the particular model of repurchases that follows.

To model debt reduction via repurchases, we assume that the firm's debt is competitively priced in credit markets. In this case, the new face value of debt $d_2^N(\Delta)$ must be such that the creditors are indifferent between whether or not to tender debt:[7]

$$D_0^N = D_0 - \Delta. \tag{6}$$

Given competitive debt pricing, we can show that:

$$\begin{aligned} d_2^N &= d_2 - \frac{\Delta}{p^*}, \text{ if } \tau c_L < d_2^N \\ &= D_0 - \Delta, \text{ if } \tau c_L \geq d_2^N. \end{aligned} \tag{7}$$

Notice that Eq. (7) also gives the new face value of debt when $\Delta < 0$; i.e., when the firm wishes to issue additional debt. The minimum possible value of Δ is such that $\tau c_H = d_2^N$, and Δ cannot be higher than either the market value of existing debt, D_0, or the firm's total internal funds, c_0:

$$\Delta_{\min} \equiv -[p^* \tau c_H + (1 - p^*)\tau c_L - D_0] \leq \Delta \leq \Delta_{\max} = \min(c_0, D_0). \tag{8}$$

Optimal Policies The optimal choice of Δ is determined by the following program:

$$\max_{\Delta \in [\Delta_{\min},\ \Delta_{\max}]} p\phi \left[g(I_H^*(\Delta)) - I_H^*(\Delta)\right] + (1-p)(1-\phi)\left[g(I_L^*(\Delta)) - I_L^*(\Delta)\right], \tag{9}$$

where $I_H^*(\Delta)$ and $I_L^*(\Delta)$ are the investment levels that obtain for each choice of Δ. Specifically, if Δ is such that the first-best investment level is feasible for a given state s, then $I_s^*(\Delta) = I^{FB}$. Otherwise, $I_s^*(\Delta)$ is equal to $I_s(\Delta)$ as determined in Section 2.2.1 (by the financial constraint, Eq. (2)).

Before we characterize the optimal solution, it is useful to understand intuitively what is accomplished by the choice of financial policy. The key intuition is established by the following Lemma.

Lemma 1 *Let $\widetilde{\Delta}$ be defined by $\widetilde{\Delta} = [D_0 - \tau c_L]$. For $\Delta < \widetilde{\Delta}$, $I_H(\Delta)$ is strictly increasing in Δ and $I_L(\Delta)$ is strictly decreasing in Δ. For $\Delta \geq \widetilde{\Delta}$, $I_H(\Delta)$ and $I_L(\Delta)$ are independent of Δ.*

In words, debt reduction at date 0 is associated with a trade-off in the future choice of investment. If a firm chooses to reduce debt, it can increase investment in the state of nature in which cash flows are high (state H). However, this decreases feasible investment in state L. Thus, state-L investment increases with the level of cash balances ($c_0 - \Delta$) that the firm carries to the future.

The intuition is as follows. If the face value of existing debt is higher than the pledgeable cash flows in state L, then the value of debt at date 0 is supported mostly by state-H cash flows. Accordingly, if the firm decides to use one unit of date 0 cash to reduce outstanding debt, it reduces the promised payment for state H by *more than one unit* (since $p^* < 1$, see Eq. (7)). As a result, state-H financing capacity goes up even though the firm carries one less unit of cash until date 1.

[7] An implication of competitive pricing is that if debt reduction enhances firm value, then this value will be captured by the firm. Importantly, we note that allowing creditors to capture a fraction of the NPV of redemption, so long as they do not capture the entire NPV, does not affect the nature of our conclusions.

If the firm is financially constrained in state H, this effect increases state-H investment. By the same token, debt capacity in state L goes up by *less than one unit*, and feasible state-L investment goes down because the firm has less cash.

The cut-off level $\widetilde{\Delta}$ represents the maximum amount of debt that can be repaid before debt becomes riskless. Once debt is riskless, the debt repayment has no effect on financing capacity. However, debt *issues*, which are feasible when $\Delta_{\min} < 0$, increase financing capacity in state L at the expense of state H even when current debt is riskless.

We can now state and prove the central result of our theory.

Proposition 1 *The optimal financial policy depends on the degree of financial constraints and on the correlation between cash flows and investment opportunities as follows:*

- *If the firm is financially unconstrained, it is indifferent between all possible Δ in the $[\Delta_{\min}, \widehat{\Delta}]$ range, where $\widehat{\Delta}$ is either equal to $\Delta_{\max}$, or to the value of Δ that renders the firm financially constrained in state L. Any value of $\Delta > \widehat{\Delta}$, if feasible, yields a lower value for the firm;*

- *If the firm is financially constrained for all Δ, then the optimal financial policy depends on the parameter ϕ:*

  a. *If $\phi \leq \frac{1}{2}$, the optimal policy is to choose $\Delta^* = \Delta_{\min}$;*

  b. *There exists a threshold level $\overline{\phi}$, satisfying $\frac{1}{2} < \overline{\phi} < 1$, such that*

     (*i*) *For $\phi \leq \overline{\phi}$, the optimal policy is to choose $\Delta^* \leq 0$,*

     (*ii*) *For $\phi > \overline{\phi}$, the optimal policy is to choose $\Delta^* > 0$;*

  c. *There exists a second threshold level $\overline{\overline{\phi}}$, satisfying $\overline{\phi} < \overline{\overline{\phi}} < 1$, such that for $\phi > \overline{\overline{\phi}}$ the optimal policy is to choose $\Delta^* = \min(\widetilde{\Delta}, \Delta_{\max})$.*

In words, Proposition 1 suggests that unconstrained firms should be indifferent between using current internal funds to increase cash holdings or to reduce debt. In contrast, financially constrained firms should display a clear preference for holding cash or reducing debt, depending on the correlation between cash flows from assets and new investment opportunities. If this correlation is zero or negative ($\phi \leq \frac{1}{2}$), the optimal policy is to increase investment in state L as much as possible. This is accomplished by making Δ equal to the lowest possible value, $\Delta_{\min}$, which might involve additional debt issues when $\Delta_{\min} < 0$. In any case, the firm has a preference towards carrying cash into the future. Furthermore, as long as the correlation is low enough ($\phi \leq \overline{\phi}$), the firm continues to prefer carrying cash to date 1 ($\Delta^* \leq 0$). However, if the correlation is high ($\phi > \overline{\phi}$), the optimal policy might involve using at least some of the firm's current internal funds c_0 to repay debt. Finally,

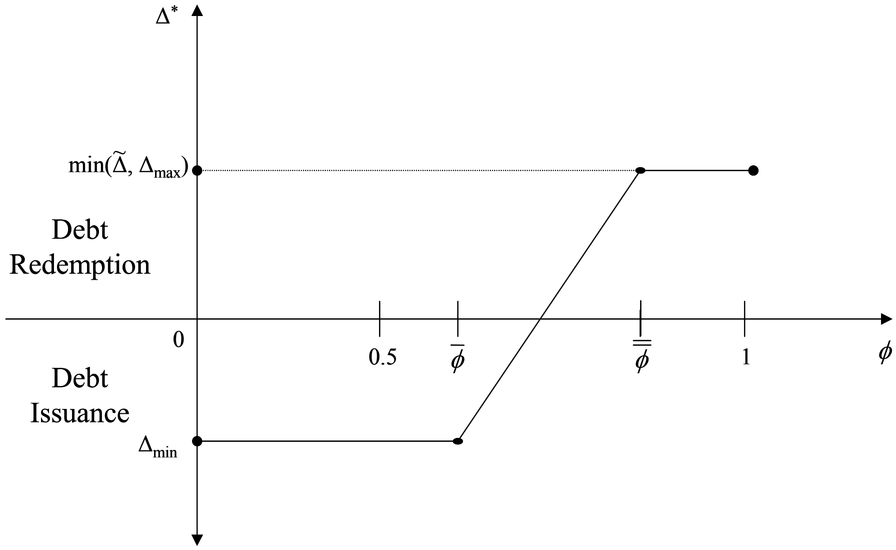

Figure 2: Optimal financial policy of a constrained firm

for very high correlation values ($\phi > \overline{\overline{\phi}}$), the constrained firm should use its current internal funds to reduce debt as much as possible, until it either exhausts its internal funds ($\Delta^* = \Delta_{\max}$), or it completely eliminates the risk of debt ($\Delta^* = \widetilde{\Delta}$).[8] These effects are depicted in Figure 2.

In order to understand our policy results, consider first the case in which the correlation between cash flows and investment opportunities is zero (i.e., $\phi = \frac{1}{2}$) and the firm is constrained. In this case, the (*ex ante*) productivity of the firm's investment is the same in both states. Because the production function is concave, the optimal investment policy involves equalizing investment levels across states. But since financing capacity is always higher in state H, the constrained firm benefits from increasing capacity in state L as much as possible. This is accomplished by making cash holdings as high as possible ($\Delta = \Delta_{\min}$), that is, by issuing as much additional debt as is feasible and carrying the new financing raised as cash reserves. If $\phi < \frac{1}{2}$ it is even more desirable to increase investment in state L. However, as the correlation parameter ϕ increases, it becomes more likely that the firm will need funds in state H because expected productivity in that state goes up. At high levels of ϕ, equalization of the marginal productivity of investment across states requires debt reduction.

It is worth noting that the effect of the likelihood of default $(1 - p^*)$ on the optimal amount of debt redemption Δ^* is not clear-cut. Recall that $p^* = [p + (1 - p)q]$. We show formally in the proof of Proposition 1 that Δ^* is increasing in p, but that the effect of q on Δ^* is ambiguous, making the

[8] To derive Proposition 1, we have assumed that the parameters are such that a constrained firm is constrained for all possible values of Δ. Given the results in Lemmas 1 and 2, a sufficient condition for this is that the firm is constrained in state H for $\Delta = \Delta_{\max}$. Because investment in state H increases with Δ, it is possible that for a large value of Δ (call it Δ_{unc}) the constrained firm becomes unconstrained in state H, while still constrained in state L. In this case, it can no longer be optimal for the firm to increase debt repayments beyond Δ_{unc}. Nevertheless, Proposition 1 would also hold in this case, with the additional condition that the optimal debt repayment amount Δ^* is lower than Δ_{unc}.

overall effect of p^* on Δ^* ambiguous (see Appendix A). A high p implies that the firm is more likely to end up in state H, where the benefits of debt reduction will be realized in the form of freed-up debt capacity. In addition, for a given Δ, p reduces feasible investment in state H (because debt repayment has a smaller effect on state-H financing capacity if p is high), thereby increasing the marginal productivity of investment in that state. Similarly, an increase in q will also increase the marginal productivity of investment in state H. However, as q increases, debt reduction becomes a less effective way of transferring resources to state H, since a part of these resources also get transferred to the high cash flow state emanating from state L (in which investment funds are not needed).

To sum up, in our model the optimality of debt reduction for a financially constrained firm depends crucially on ϕ, the correlation between investment opportunities and cash flows, but not necessarily on the likelihood of default of the firm. In contrast, a financially unconstrained firm can achieve first-best investment levels irrespective of financial policy, and thus small changes in Δ have no effect on investment and value. The only policy that is suboptimal for an unconstrained firm is to reduce cash holdings so much that the firm becomes constrained in state L (cf. Proposition 1).

Our model yields comparative statics results that naturally lend themselves to empirical testing. We present and discuss these comparative statics in turn.

Proposition 2 *Suppose the firm is financially constrained for all Δ. We obtain the following effects on the firm's cash and debt policies from a variation in the availability of internal funds, c_0:*

- *If the correlation between cash flows and investment opportunities is low ($\phi \leq \frac{1}{2}$), then a change in c_0 should result in a corresponding change in the firm's cash balances ($\frac{\partial c_1}{\partial c_0} > 0$), but not in the amount of debt outstanding ($\frac{\partial \Delta}{\partial c_0} = 0$).*
- *If the correlation between cash flows and investment opportunities is high ($\phi > \overline{\overline{\phi}}$), then a change in c_0 should change the amount of debt outstanding ($\frac{\partial \Delta}{\partial c_0} > 0$), but not the firm's cash balances ($\frac{\partial c_1}{\partial c_0} = 0$).*

These comparative statics results follow directly from the optimal policies characterized in Proposition 1. If the correlation ϕ is low, then the firm does not benefit from debt repayment. Consequently, increases (decreases) in internal funds result in increases (decreases) in the amount of cash balances held by the firm. For very high correlation levels, however, the firm's optimal policy is such that it benefits more from debt repayments than from holding cash. In this range, changes in internal funds lead to same-direction changes in debt levels.[9]

[9] For intermediate correlation levels ($\phi \in (\frac{1}{2}, \overline{\overline{\phi}})$), the firm is in an equilibrium in which internal funds are split between debt repayments/issues and cash balances (cf. Proposition 1). In this range, intuition would suggest that an increase in cash flows would lead *both* to an increase in cash ($\frac{\partial c_1}{\partial c_0} > 0$) and to a smaller increase (or a higher

2.3 Robustness

In order to derive Propositions 1 and 2 in a parsimonious fashion, we assumed that cash reserves are not pledgeable to creditors (Assumption IIIA). We now revert to the case with general τ^C (Assumption III) in order to illustrate the robustness of the conclusions drawn under our basic model. In addition, we also show that our results carry over to a setting in which the firm makes investments at date 0 as well as at date 1.

2.3.1 Making Cash Reserves Pledgeable

Our results also extend to a setting in which we allow creditors to have priority over the firm's cash reserves at date 2. Admittedly, while it simplifies our analysis, assuming that creditors cannot seize the firm's cash reserves at date 2 is somewhat unappealing. Accordingly, in this section we revert Assumption IIIA to its general case in Assumption III, essentially allowing τ^C to be greater than zero. In doing this, we continue to assume that firms can always tap their cash reserves at date 1 if investment opportunities arise — as we argued earlier, this is an optimal contracting outcome in our model.

Allowing $\tau^C > 0$ alters the market-values of debt, and, in turn, the expression for the new face value of debt, d_2^N, after a debt reduction of amount Δ at the market price. If their claim is in default at date 2, creditors can access a fraction τ of the cash flow c_L as well as a fraction τ^C of the cash reserve c_1, provided that the cash reserve c_1 was not deployed for investments at date 1. The market value of existing debt is then given by

$$D_0 = p^* d_2 + (1 - p^*) \left[(1 - \phi) \min(\tau c_L, d_2) + \phi \min(\tau c_L + \tau^C c_1, d_2) \right]. \tag{10}$$

Existing debt is in default with probability $(1 - p^*)$. Because all default events happen in state L, the probability that arrival of an investment opportunity is subsequently followed by default is $(1 - p^*)(1 - \phi)$. In this case, creditors can only access the cash flow c_L. With probability $(1 - p^*)\phi$ the firm is in default at date 2 and no investment was made at date 1. In this case, creditors can also access the cash reserve c_1.

After a debt reduction of amount Δ, the new face value of debt d_2^N and the new market value D_0^N must satisfy:

$$D_0^N = p^* d_2^N + (1 - p^*) \left[(1 - \phi) \min(\tau c_L, d_2^N) + \phi \min(\tau c_L + \tau^C c_1, d_2^N) \right]. \tag{11}$$

These equations imply that in contrast to our earlier analysis, the relationship between d_2^N and d_2 must be specified over three regions: a region of "small" debt reductions, a region of "moderately

reduction) in debt ($\frac{\partial \Delta}{\partial c_0} > 0$). Nevertheless, the precise change in financial policies depends also on the rate of change of the marginal productivities following a change in cash flows — the comparative statics are less clear in this range. Proposition 2 focuses on correlation ranges for which implications are clear-cut.

large" debt reductions, and another of "large" debt reductions. In particular, we obtain

$$
\begin{aligned}
d_2^N &= d_2 - \frac{\Delta}{p^*}, \text{ if } \tau c_L < \tau c_L + \tau^C c_1 < d_2^N \\
&= d_2 - \frac{(1-p^*)\phi[d_2 - \tau c_L - \tau^C c_0]}{[p^* + (1-p^*)\phi]} - \frac{[1 + (1-p^*)\phi\tau^c]\Delta}{[p^* + (1-p^*)\phi]}, \\
&\qquad \text{if } \tau c_L < d_2^N < \tau c_L + \tau^C c_1 \\
&= D_0 - \Delta, \text{ if } \tau c_L \geq d_2^N.
\end{aligned} \tag{12}
$$

The first and the third cases correspond respectively to "small" Δ and "large" Δ, and are similar to the case we analyzed before. In the "moderately large" Δ region, it can be verified that $d_2^N < d_2$ for $\Delta > 0$, and that d_2^N is decreasing in Δ at a rate that is greater than one. So long as this property holds, the analysis remains qualitatively identical to that in the basic model. This property implies that $I_H(\Delta)$ is increasing in Δ, and thus that Propositions 1 and 2 also hold. In particular, the conclusion that $I_H(\Delta)$ is increasing in Δ holds irrespective of the value of τ^C. We can state that the specific value of τ^C is qualitatively irrelevant for the results of our model.

2.3.2 Date 0 Investment

We also solve a version of our model in which we introduce a date 0 investment opportunity. Our basic model assumes that the firm has no alternative use for its internal resources, and thus it allocates the currently available internal funds (c_0) entirely towards cash or (lower) debt. This assumption simplifies the exposition of our theory; in particular, it allows us to focus directly on the marginal trade-off between cash and negative debt. However, one cannot generally assume that date 0 investment is exogenous to the financial policy problem solved above. Unlike the direct extension in Section 2.3.1, the analysis of date 0 investment is more involved. Thus, for the sake of brevity, we relegate the solution details to Appendix B.

A specific feature of our model that we highlight here is that it does not require any assumptions regarding debt repurchases (see Section 2.2.2 above). In this modified set up, if the constrained firm wishes to carry less debt into the future it will simply issue less debt today. In particular, the notion of "negative debt" does not necessarily entail active debt redemption as in the simple model that we present in the main text.

As Appendix B shows, our previous conclusions carry over to this modified set up. The correlation between cash flows and investment opportunities continues to determine the cash versus negative debt aspect of the constrained firm's financial policy. In particular, we show that if hedging needs are high, then it is optimal for the constrained firm to carry high cash balances into the future. For instance, the firm issues debt at date 0 not just to fund the date 0 investment but to also build up cash reserves. As hedging needs decrease, it becomes optimal for the constrained firm to save debt capacity for future good states of the world. As a result, the firm uses cash reserves to fund date 0 investment, and, in turn, also issues less debt at date 0. These results are exactly in the spirit of Proposition 1 above.

In addition, we obtain comparative statics results that resemble, but not identical to those in Proposition 2. The new result in this extension is that if hedging needs are high, cash flow sensitivities of debt are actually predicted to be *positive*, instead of zero as in Proposition 2. As we explain in detail in the appendix, the intuition is that higher cash flows allow the constrained firm to invest more at date 0, and because debt capacity is linked to investment returns, the firm can also borrow a greater amount at that date (a multiplier effect). Hence, it is not only the case that constrained firms with high hedging needs should *not* use current cash flows to reduce outstanding debt, but they could actually display a positive relationship between cash flows and current net debt issues.

2.4 Empirical Implications

Our theory's key empirical implications concern how constrained firms should allocate cash flows into cash and debt balances. As we have emphasized, this dimension of financial policy is governed by a hedging motive — captured by the correlation between cash flows and investment opportunities under constrained financing. We can summarize our model's implications as follows:

Implication 1 If the correlation between cash flows and investment opportunities is low (the firm has high hedging needs), then constrained firms allocate their "free" operating cash flows primarily into cash balances. Their propensity to use cash flows towards debt reduction is small. Hence, these firms' cash flow sensitivity of cash, defined as the fraction of excess cash flow allocated to cash holdings, should be positive. In addition, their cash flow sensitivity of debt, defined as the effect of cash flows on outstanding debt, should not be significantly negative. In fact, cash flow sensitivities of debt could be positive for these firms, because of the multiplier effect mentioned in Section 2.3.2.

Implication 2 If the correlation between cash flows and investment opportunities is high (low hedging needs), then constrained firms should display a relatively weaker propensity to save cash, and a stronger propensity to use current cash flows to reduce debt. Hence, these firms' cash flow sensitivity of debt should be more negative, while their cash flow sensitivity of cash should be less positive than those of firms with high hedging needs.

Notice that the theory has less clear implications for the *average level* of the cash flow sensitivities of cash and debt for constrained firms. Because constrained firms have an incentive to save financing capacity for the future, intuition suggests that the cash flow sensitivity of cash (debt) should generally be positive (negative). However, our theory implies that one might observe different sensitivity patterns depending on the distribution of hedging needs in the sample. We shall look at these issues in the empirical section.

A relevant observation is that the prediction that the cash flow sensitivity of debt should be negative for some constrained firms does not imply that such firms must *redeem* debt. As discussed in Section 2.3.2, the basic model's prediction that some constrained firms use cash flows to redeem debt might translate into a propensity to reduce the amount of debt that the firm currently issues. In other words, on net terms, the firm may or may not display positive debt issuance activities, yet those activities should *fall* in response to cash flow innovations.

Regarding unconstrained firms, our benchmark model predicts that their cash and debt policies should not necessarily relate to cash flow surpluses, or to their hedging needs. In the strictest sense, unconstrained firms do not have any need to hedge in our model. Nevertheless, to facilitate comparisons, we also use the term "high and low hedging needs" for unconstrained firms depending on whether the correlation between cash flows and investment opportunities is low or high, respectively.

Note also that the strict indeterminacy of financial policies for unconstrained firms in our model only holds in the absence of other costs and benefits of cash and debt. We show in Appendix C that in the presence of an additional cost of carrying cash, unconstrained firms will generally prefer to use excess cash flows to reduce debt instead of adding more cash to their balance sheets. Likewise, in the presence of an additional benefit of holding cash (or a benefit to carrying debt), unconstrained firms will prefer saving cash as opposed to reducing debt. Crucially, because these additional costs and benefits are orthogonal to the financing constraints rationale that we use to derive Propositions 1 and 2, we also show that they do not change the nature of the results derived for constrained firms. For example, if there is an additional cost of carrying cash, constrained firms' hedging needs have to be higher in order to induce them to save cash. This effect only changes the particular value of the correlation cut-off $\overline{\phi}$ below which constrained firms prefer to hold cash, not our comparative statics.

Finally, notice that because unconstrained firms do not need to worry about future financing capacity, their cash and debt policies lack a hedging motive. In practical terms, this implies that irrespective of the *levels* of the cash flow sensitivities of cash and debt one might observe for unconstrained firms, these sensitivities should *not depend* on the correlation between cash flows and investment opportunities. This insight provides us with a way to identify our model irrespective of the average levels of cash flow sensitivities that we observe for constrained and unconstrained firms.

We summarize the above considerations in an additional implication.

Implication 3 The levels of unconstrained firms' cash flow sensitivities of cash and debt may differ from zero if there are additional costs or benefits of cash and debt. However, these sensitivities should be independent of the correlation between cash flows and investment opportunities.

3 Empirical Tests

3.1 Sample Selection Criteria

To test our model's predictions we use a sample of manufacturing firms (SICs 200–399) taken from COMPUSTAT's P/S/T, Full Coverage, and Research annual tapes over the 1971–2001 period. We require firms to provide valid information on their total assets, sales, debt, market capitalization, cash holdings, operating income, depreciation, tax payments, interest payments, and dividend payments. We deflate all series to 1971 dollars.

Our data selection criteria and variable construction approach follows that of Almeida et al. (2004), who study the impact of financing constraints on the management of internal funds, and that of Frank and Goyal (2003), who look at external financing decisions. Similarly to Frank and Goyal we look at changes in debt and cash positions using data from firms' "flow of funds statements" (available from 1971 onwards).[10] As in Almeida et al., we discard from the raw data those firm-years for which the market capitalization is less than \$10 million as well as firm-years displaying asset or sales growth exceeding 100%. The first screen eliminates from the sample those firms with severely limited access to the public markets — our theory about the internal–external funding interplay implies that the firm does have active (albeit potentially constrained) access to funds from the financial markets. The second screen eliminates those firm-years registering large jumps in their business fundamentals (typically indicative of major corporate events).

In identifying in the data those firms with active cash and debt policies, we further require that firms have at least \$0.5 million in cash in their balance sheets, and that they register positive debt in at least one year of the sample period. For our purposes, it is important that we minimize the sampling of distressed firms. Cash and debt policies of distressed firms may be primarily driven by their desire to avoid bankruptcy costs (see Smith and Stulz (1985) and Acharya, Huang, Subrahmanyam, and Sundaram (2000)). In contrast, the underlying rationale for cash and debt policies that we emphasize in our theory is largely unrelated to financial distress. Accordingly, we require that firm annual sales exceed \$1 million and we eliminate firm-years for which debt exceeds total assets (near-bankruptcy firms).[11]

Finally, we also eliminate those firms whose net debt issuance or repurchase exceed the value of their total assets for the year (see Lemmon and Zender (2004)), and those whose market-to-book asset ratio (or Q) is either negative or greater than 10 (see Gilchrist and Himmelberg (1995) and Almeida and Campello (2004)). Also following Gilchrist and Himmelberg and Almeida and

[10] The use of data from the flow of funds statements ensures that the changes in cash and debt figures that we observe are associated with actual flows of resources as opposed to simple accounting restatements.

[11] We will later experiment with restricting the sample according to direct measures of financial distress, such as Altman's Z-score and the interest coverage ratio.

Campello, we try to minimize the impact of sample attrition on the stability of the data process by requiring that firms provide over five years of valid information on their debt and cash policies. In fact, requiring firms to appear for a minimum of periods in the sample serves an important objective: it allows us to compute a robust empirical counterpart of the notion of firms' "hedging needs" (more on this shortly). Our final sample consists of 20,146 firm-year observations. Descriptive statistics for the key empirical variables we construct using this sample are provided below.

3.2 Methodology

To test our theory, we need to specify an empirical model that allows us to see how cash flow innovations are absorbed by cash savings and debt issuance policies. We also need to identify in the data both financially constrained and unconstrained firms. Finally, we need an empirical counterpart for the notion hedging needs. We tackle each one of these issues in turn.

3.2.1 Empirical Specification

We examine the simultaneous, within-firm responses of cash and debt policies to cash flow innovations across sets of constrained and unconstrained firms through a system of equations. The equations in the system are parsimoniously specified. In addition to firm size and variables that are needed to identify the system, the financial policy equations only include proxies that we believe are related to the primitives of our theory: cash flows and investment opportunities. Furthermore, rather than regarding marginal cash savings and debt issuance/repurchase decisions as orthogonal to each other, we fully endogenize debt and cash policies in our system of equations. In this way, the impact of cash flow on cash savings accounts for marginal, contemporaneous net debt issuance/repurchase decisions. And the same goes for the impact of cash flows on marginal debt decisions — they, too, endogenize cash policies.[12]

Define $\Delta Debt$ as the ratio of the net long-term debt issuances (COMPUSTAT's item #111 – item #114) to total book value of assets (item #6), and $\Delta CashHold$ as changes in the holdings of cash and other liquid securities (item #234) divided by total assets. *CashFlow* is an empirical measure that is designed to proxy for "excess cash flow" in our theory. Recall, we want to study a firm's use

[12] To see how spurious inferences could be drawn if cash and debt policies are not corrected for endogeneity, consider the case of a firm facing increased demand for investment (say, because it learns about the existence of positive NPV projects in its opportunity set). Depending on the underlying correlation between the firm's cash flows and investment opportunities (hedging needs), we could have the case in which the firm both issues debt and observes a high cash flow. Clearly, the mechanical ("pure accounting") effect of a debt issuance is to increase the firm's cash stocks, as the proceeds from security issuances are parked in the firm's cash accounts until capital is ultimately purchased. Under this scenario, it is easy to see that a regression of changes in cash reserves on cash flows alone will lead to the spurious conclusion that the firm is "saving cash out of cash flows." Likewise, when making inferences about the sensitivity of debt changes to cash flows, one would like to account for changes in the firm's cash stocks: we cannot determine if a firm reduces debt (as opposed to saving cash) in response to cash flow shocks unless we net out the effect of changes in cash balances from the association between debt and cash flows.

of "uncommitted" cash inflows towards its cash and debt balances. In empirically measuring these inflows, we start from the firm's gross operating income (COMPUSTAT's item #13) and from it subtract amounts committed to capital reinvestment (proxied by asset depreciation, or item #14), to the payment of taxes (item #16), to the payment of debtholders (interest expense, item #15), and to payments to equity holders (dividends, items #19 and #21). We then scale the remainder by the book value of assets.[13] Our basic proxy for investment opportunities, Q, is computed as the market value of assets divided by the book value of assets, or (item #6 + (item #24 × item #25) − item #60 − item #74) / (item #6). Throughout the analysis we gather estimates from the following 3SLS system:

$$\begin{aligned} \Delta Debt_{i,t} &= \alpha_0 + \alpha_1 CashFlow_{i,t} + \alpha_2 Q_{i,t} + \alpha_3 Size_{i,t} \\ &\quad + \alpha_4 \Delta CashHold_{i,t} + \alpha_5 Debt_{i,t-1} + \sum_i firm_i + \sum_t year_t + \varepsilon^d_{i,t,} \end{aligned} \tag{13}$$

$$\begin{aligned} \Delta CashHold_{i,t} &= \beta_0 + \beta_1 CashFlow_{i,t} + \beta_2 Q_{i,t} + \beta_3 Size_{i,t} \\ &\quad + \beta_4 \Delta Debt + \beta_5 CashHold_{i,t-1} + \sum_i firm_i + \sum_t year_t + \varepsilon^c_{i,t}, \end{aligned} \tag{14}$$

where *Size* is the natural log of sales (item #12), and *firm* and *year* absorb firm- and time-specific effects, respectively.[14]

Our theory's central predictions concern the responses of debt issuance and cash savings to cash flows, captured by α_1 and β_1 in Eqs. (13) and (14), respectively. Lagged *levels* (i.e., stocks) of the dependent variables in those equations are entered in order to identify the system.[15] Accordingly, *Debt* in Eq. (13) is defined as COMPUSTAT's item #9 over item #6, and *CashHold* in (14) is item

[13] Implicitly, we take depreciation (item #14) as a minimum amount of investment needed to avoid asset depletion. In this vein, we see it as a proxy for "nondiscretionary" investment (observed investment spending is, of course, a more discretionary measure of investment). Dividends can be seen as discretionary; however, in practice firms do not seem to fine-tune their dividend policy according to their cash flow process (dividends are relatively sticky, whereas cash flows are not). We also experimented with the idea of computing *CashFlow* without the inclusion of dividends and our findings were qualitatively similar. The same happens if, following a number of studies in the capital structure literature, we compute *CashFlow* as net income before extraordinary items (COMPUSTAT's item #18).

[14] An alternative approach to the question of how cash and debt balances respond to cash flow innovations across constrained and unconstrained firms is to run the following set of (stacked) OLS regressions across the two constraint firm-types:

$$\Delta Debt_{i,t} = \alpha_0 + \alpha_1 CashFlow_{i,t} + \alpha_2 Q_{i,t} + \alpha_3 Size_{i,t} + \sum_i firm_i + \sum_t year_t + \varepsilon^d_{i,t},$$

$$\Delta CashHold_{i,t} = \beta_0 + \beta_1 CashFlow_{i,t} + \beta_2 Q_{i,t} + \beta_3 Size_{i,t} + \sum_i firm_i + \sum_t year_t + \varepsilon^c_{i,t}.$$

When we experiment with this SUR-like OLS system we also get results that fully agree with our theory. As we discuss above, however, using an estimator that, for each sampled firm, simultaneously endogenizes the impact of debt issuance activity on cash policies and vice-versa — in the way the 3SLS does — provides for the appropriate empirical testing framework for our theory.

[15] Our results also hold when we use twiced lagged levels of debt and cash and when we use the projections of those firm proxies onto indicators for industry-years.

#1 over item #6. We explicitly control for possible biases stemming from unobserved individual heterogeneity and time idiosyncrasies by expunging firm- and time-fixed effects from our slope coefficient estimates. In fitting the data, we allow residuals to be correlated across our debt and cash models; that is, reported t-statistics are deflated to account for cross-equation residual correlation.

3.2.2 Financial Constraints Criteria

Testing the implications of our model requires separating firms according to *a priori* measures of the financing frictions that they face. There are a number of plausible approaches to sorting firms into financially constrained and unconstrained categories, and we do not have strong priors about which approach is best. Following Almeida et al. (2004), we use a number of alternative schemes to partition our sample:

- Scheme #1: In every year over the 1971 to 2001 period, we rank firms based on their payout ratio and assign to the financially constrained (unconstrained) group those firms that are in the bottom (top) three deciles of the annual payout distribution. We compute the payout ratio as the ratio of total distributions (dividends and repurchases) to operating income. The intuition that financially constrained firms have significantly lower payout ratios follows from Fazzari, Hubbard, and Petersen (1988), among many others, in the financial constraints literature. In the capital structure literature, Fama and French (2002) use payout ratios as a measure of the difficulties firms may face in assessing the financial markets.

- Scheme #2: We rank firms based on their asset size over the 1971 to 2001 period and assign to the financially constrained (unconstrained) group those firms that are in the bottom (top) three deciles of the size distribution. The rankings are again performed on an annual basis. This approach resembles that of Gilchrist and Himmelberg (1995) and Erickson and Whited (2000), who also distinguish between groups of financially constrained and unconstrained firms on the basis of size. Fama and French (2002) and Frank and Goyal (2003) also associate firm size with the degree of external financing frictions. The argument for size as a good observable measure of financial constraints is that small firms are typically young, less well known, and thus more vulnerable to capital-market imperfections.

- Scheme #3: We retrieve data on firms' bond ratings and categorize as being financially constrained those firms that never had their public debt rated during our sample period. Given that unconstrained firms may choose not to use debt financing and hence may not have a debt rating, we only assign to the constrained subsample those firm-years that *both* lack a rating and report positive debt (see Faulkender and Petersen (2004)).[16] Financially unconstrained

[16] Firms with no bond rating and no debt are considered unconstrained, but our results are not affected if we treat

firms are those whose bonds have been rated during the sample period. Related approaches for characterizing financial constraints are used by Whited (1992), Gilchrist and Himmelberg (1995), and Lemmon and Zender (2004). The advantage of this measure over the former two is that it gauges the *market*'s assessment of a firm's credit quality. The same rationale applies to the next measure.

- Scheme #4: We retrieve data on firms' commercial paper ratings and categorize as being financially constrained those firms that never display any ratings during our sample period. Observations from these firms are only assigned to the constrained subsample in the years a positive debt is reported. Firms whose commercial papers receive ratings during our sample period are considered unconstrained. This approach follows from the work of Calomiris, Himmelberg, and Wachtel (1995) on the characteristics of commercial paper issuers.

Table 1 reports the number of firm-years under each of the eight financial constraint categories used in our analysis. According to the payout scheme, for example, there are 6,153 financially constrained firm-years and 6,231 financially unconstrained firm-years. The table also shows the extent to which the four classification schemes are related. For example, out of the 6,153 firm-years classified as constrained according to the payout scheme, 2,680 are also constrained according to the size scheme, while a smaller number, 1,078 firm-years, are classified as unconstrained. The remaining firm-years represent payout-constrained firms that are neither constrained nor unconstrained according to size. In general, there is a positive correlation among the four measures of financial constraints. For example, most small (large) firms lack (have) bond ratings. Also, most small (large) firms have low (high) payout policies. However, the table also makes it clear that these cross-group correlations are far from perfect.

– insert Table 1 here –

3.2.3 Measuring Hedging Needs

To identify firms that have a high need for hedging, we examine the relationship between firms' free operating cash flows and a proxy for investment opportunities that is both exogenous to their internal cash flow process and extraneous to our baseline empirical model (Eqs. (13) and (14)). Note that we cannot look directly at the correlation between a firm's cash flows and investment spending, since the two are endogenously related when firms are financially constrained. The same is true for the correlation between a firm's cash flows and Q if the anticipation of a firm's ability

these firms as neither constrained nor unconstrained. We use the same criterion for firms with no commercial paper rating and no debt in scheme #4. In unreported robustness checks, we have restricted the sample to the period where firms' bond ratings are observed every year (from 1986 to 2001), allowing firms to migrate across constraint categories. Our conclusions are insensitive to these changes in sampling window and firm assignment criteria.

to pursue profitable investment opportunities is already capitalized in its stock price. We consider three alternative measures of investment opportunities that fit the above requirements, all of which are based on industry-level proxies.

First, following the literature that links expenditures in product research and development to investment opportunities (see, e.g., Graham (2000) and Fama and French (2002)), we look at the correlation between a *firm*'s cash flow from current operations (*CashFlow*) and its *industry-level* median of R&D expenditures to assess whether a firm's availability of internal funds is correlated with the firm's demand for investment funds.[17] We compute this correlation, firm by firm, identifying the firm's industry using its three-digit SIC code. We then partition our sample into firms displaying low and high correlation between investment demand and supply of internal funds. To be precise, recall that our theory has particularly clear implications for cash and debt policies of constrained firms at the high and low ends of the correlation between cash flows and investment opportunities. Accordingly, we assign to the group of "low hedging needs" those firms for which the empirical correlation between cash flow and industry R&D is above 0.2, and to the group of "high hedging needs" those firms for which this correlation is below –0.2. We emphasize that although these cut-offs may seem arbitrary, they ensure that firms in either group have correlation coefficient estimates that are statistically reliable.[18] Moreover, our results are robust to changes in these cut-offs (e.g., ±0.1 or ±0.3).

The second measure of investment opportunities we consider is related to observed product-market demand. Specifically, for each firm-year in the sample we compute the median three-year-ahead sales growth rate in the firm's three-digit SIC and then compute the correlation between the firm's cash flow and this measure of industry sales growth. The premise of this approach is that firms' perceived investment opportunities (and demand for investment funds) will be related to estimates of future sales growth in their industries and that those estimates, on average, coincide with the data. To be consistent with the first characterization of hedging needs, we also set cut-offs for high and low hedging needs at correlation coefficients of 0.2 and –0.2, respectively.

The third measure we use to capture investment opportunities is somewhat closer to that contained in our empirical model; we look at Q. Crucially, rather than relying on a firm's industry *level* of Q, which could be highly related to the firm's Q itself (and recall, this is included in the specification), we look at *changes* in the firm's industry median Q. By looking at changes in industry Q we remove the fixed, level component of Q and yet retain a reasonably good proxy for innova-

[17] R&D expenditures are measured as COMPUSTAT item #46 divided by item #6. Recall, all of the firms in our sample come from the manufacturing sector. Industries in this sector of the economy are relatively homogeneous in a number of dimensions. We think of temporal, cross-industry differences in R&D expenditures as a phenomenon that is correlated with the emergence of differential growth opportunities across industries (caused, for example, by changes in consumer preferences and technological innovation).

[18] This point is important in that our sample, although large in the cross-section dimension, is limited in the time series dimension (this is the dimension used to compute the correlation between firm-level cash flows and industry-level investment opportunities).

tions in investment opportunities that different firms face. Once again we use the ± 0.2 cut-offs for correlation coefficients between firm cash flow and this measure of investment opportunities when assigning firms to low and high hedging needs groups.

3.3 Sample Characteristics

To test our theory, we must identify groups of firms facing differential levels of financial constraints and hedging needs. To our knowledge, no previous study has differentiated firms along both of these dimensions. Hence, it is important that we highlight and discuss basic differences in firm characteristics across constrained/unconstrained subsamples and low/high hedging needs subsamples. Presenting these descriptive statistics is interesting in its own right, but it also helps us assess the merits of candidate alternative explanations for our central (multivariate-based) empirical findings.[19]

To recap, our analysis suggests four firm-types based on the intersection of the degree of financial constraints and the degree of hedging needs. And we consider four measures of financial constraints and three measures of hedging needs. Thus, for every empirical variable we examine, our categorization scheme yields 48 sets of statistics ($4 \times 4 \times 3$). In the interest of completeness and robustness, we summarize each of the central empirical proxies used in our analysis across all possible categorizations. This summary is provided in Table 2, which reports mean, median, and number of observations for beginning-of-period long-term debt to asset ratio (*Debt*), beginning-of-period cash to asset ratio (*CashHold*), net cash flow scaled by assets (*CashFlow*), the market-to-book asset ratio (Q), and the net difference between debt issuance and repurchase scaled by assets ($\Delta Debt$). The table also shows a standard measure of financial distress (*Z-Score*) in order to aid some of our discussion.[20]

Because our sampling approach and variable construction methods follow the existing literature, it is not surprising that the numbers we report in Table 2 resemble those found in related studies (see, e.g., Frank and Goyal (2003) and Almeida et al. (2004)). In particular, as in Frank and Goyal, average leverage ratios fluctuate around 0.19 and average Q's hover around 1.6. The figures for net debt issues and cash flows are also comparable across the two papers; note, however, that Frank and Goyal scale debt issuances by net (as opposed to total) assets. More important for our purposes, note that there seems to be only limited evidence that any of these proxies vary systematically across the four firm-types we study. So, for example, constrained firms seem to carry more debt according to some characterizations (e.g., based on payout policy), but less according to others

[19] Sample summary statistics can only go so far in providing evidence of any theory on the *marginal* allocation of funds and financing decisions. We cannot, for example, use summary statistics on cash stocks to draw inferences about the dynamics of hedging needs and cash savings — at any point in time, a firm's observed cash stocks will reflect (i.e., confound) *ex ante* policies and *ex post* outcomes. Our multivariate analysis, in contrast, is designed to shed light on firms' hedging needs and marginal cash savings decisions following cash flow innovations.

[20] Here we use Altman's "unleveraged" Z-Score measure (as also used by Frank and Goyal (2003)), computed as 3.3×(item #170/item #6) + (item #12/item #6) + 1.4×(item #36/item #6) + 1.2×((item #4–item #5)/item #6).

(e.g., size); with no significant variation between firms with high and low hedging needs within the same constraint type. Consistent with intuition, some characterizations suggest that constrained firms are more profitable and/or have higher growth opportunities (see statistics for low dividend paying firms). However, notice that (1) these differences are not always robust within and across the panels of Table 2, (2) differences are economically insignificant (e.g., Q's are overall economically similar across firm-types), and (3) there are no systematic differences between constrained firms with high and low hedging needs (even though some slight subsample patterns appear to arise, we have verified that they are generally statistically insignificant). In all, differences in investment opportunities and/or cash flows are unlikely to provide alternative explanations for why joint cash and debt policies should vary across our four categories of firms.

– insert Table 2 here –

Statistics for cash holdings are similar to those in Almeida et al., whose study focuses on this particular variable. As in their paper, we also find that constrained firms hold far more cash on average than unconstrained firms. However, there is little systematic variation across firms with different hedging needs — even though low hedging needs firm appear to carry more cash on average, differences across firm-types are most of the time statistically insignificant. Finally, we consider differences in financial distress measures across firms in our sample using Altman's Z-Score. One could argue that financial distress alone may drive differences in the way firms make their cash and debt choices. While we do not dispute this hypothesis, it poses a challenge to our story only if we find that underlying patterns in the likelihood of financial distress are systematically different across our four firm-types. We have no priors as to why financial distress will influence our assignment of firms in a systematic way, but we let the data tell us if such a sample-selection bias exists. The second to last column in each of the panels A though C in Table 2 reveals no systematic relation between financial constraints, hedging needs, and financial distress. This is a reassuring finding that is consistent with unreported robustness checks in which we show that the exclusion of firms with high risk of financial distress (Z-scores below 1.81 and interest coverage ratios below 1) from our 3SLS estimations does not affect our conclusions.[21]

One aspect of our characterization of the data that is new to the literature regards the propensity of firms to issue or repay debt given the financial constraints and investment opportunities that they face. The mean and medians reported in the last column in each of the panels of Table 2 suggest that unconstrained firms, on net terms, seem to issue more debt than constrained firms.

[21] Our conclusions are also unaffected when we remove from the sample those firms with consecutive operating losses (two or more consecutive years of negative profits) and those firms high earnings volatility (over three standard deviations from their three-digit SIC industry means). Noteworthy, firms in these categories are roughly equally distributed among the high and low hedging needs categories.

However, these statistics reveal little about the frequency with which these firms approach capital markets to raise additional debt or repay outstanding debt. In order to shed light on the frequency with which our sample firms tap the market for debt securities, for each one of our four firm-types, we computed the number of firm-years for which either no issuance or repurchase activity is registered, and also the number of firm-years in which debt issues surpass repurchases, and vice-versa. In the interest of brevity we only report and discuss these results in the text (the tables are readily available upon request).

We find that the frequency with which constrained and unconstrained firms act on their own debt accounts is not very different. The percentage of constrained firm-years that neither issue nor repurchase debt is roughly in the 3–6% range (depend on the constraint criteria used), while the percentage of unconstrained firms that also do nothing to their debt accounts is in a similar 3–6% range. This suggests that a large proportion of firms in each one of our four firm groups is active in the debt markets. In addition, constrained firms tend to make more trips to debt markets in order to repurchase debt (net repurchase activities are registered by some 50 to 60% of the constrained firm-years), while unconstrained firms display the opposite pattern (net issuance activities in the 47–53% range). In other words, while rejecting the notion that constrained firms are largely inactive in the debt markets, our frequency tests reveal that constrained firms issue debt somewhat less frequently than unconstrained firms and manage their debt accounts with more frequent repurchase initiatives. Finally, we observe that the overall frequency of debt issuances and repurchases varies little across the dimension of hedging needs.

3.4 Debt and Cash Policies across Constrained and Unconstrained Firms

Our testing approach requires us to compare the cash flow sensitivities of cash and debt estimated from Eqs. (13) and (14) across groups of firms, sorted *both* on measures of constraints and of hedging needs. Before we do that, we present some preliminary regressions in which we consider only the differences between constrained and unconstrained firms; i.e., without sorting on hedging needs. The purpose of this is two-fold. First, it is interesting to see the average pattern of cash flow sensitivities for unconstrained firms: this average pattern provides evidence on the net costs of cash and debt in the absence of constraints and thus provides a benchmark against which to evaluate the results obtained for constrained firms. Second, these regressions allow for direct comparisons with previous papers in the literature on marginal financing decisions. While those papers do not consider the hedging dimension we are exploring, it is important that we are able to replicate their primary findings in our data.

Table 3 presents the results obtained from the estimation of our baseline regression system (Eqs. (13) and (14)) within each sample partition described in Section 3.2.2. A total of 16 estimated results are reported in the table (2 equations $\times$ 4 constraint criteria $\times$ 2 firm-types per constraint criterion). Results from the debt regressions (in Panel A) make it clear that constrained firms have no systematic tendency to change their debt positions following a cash flow innovation. This is in sharp contrast to the policies of financially unconstrained firms. For each new dollar of excess cash flow, an unconstrained firm will reduce the amount of debt it issues by approximately 25 to 33 cents — the cash flow sensitivities of debt for unconstrained firms are all significant at better than the 1% test level. This negative relationship between cash flows and debt issues is consistent with the findings of Shyam-Sunder and Myers (1999), who report that debt issues are positively related to a firm's financing deficit for the types of firms that we classify as unconstrained.[22] In turn, results from the cash regressions (Panel B) conform to those of Almeida et al. (2004). Under each constraint criterion, the set of financially constrained firms display a significantly positive relationship between excess cash flows and changes in cash holdings — their cash flow sensitivities of cash are all significant at better than the 1% test level. Unconstrained firms, in contrast, do not display any systematic propensity to save cash out of excess cash flows.

– insert Table 3 here –

As discussed in Section 2.4, our theory makes clearer predictions about the relationship between cash flow sensitivities and hedging needs than about the average level of those sensitivities across financial constraints alone. This is partly because the theory does not pin down the levels of the sensitivities for unconstrained firms, and partly because the average level of the sensitivities for constrained firms depends on the distribution of hedging needs within these firms. Nonetheless, one can rationalize the "overall, average" results from Table 3 as follows. Unconstrained firms seem to display a preference towards using cash flows to reduce debt instead of holding cash in their balance sheets. This finding indicates that holding cash is relatively costly for these firms, perhaps because cash has low yield and/or it can be diverted by management (our examination need not take a stand of these exact costs). In contrast, constrained firms choose to retain cash *in spite* of the fact that cash retention may be relatively costly. This finding alone suggests that cash has a relevant economic role to play when firms are financially constrained. Finally, the additional finding that debt is not systematically related to cash flows for constrained firms suggests that these firms on average prefer positive cash over negative debt.

To show that cash and debt policies of constrained firms are influenced by our theoretical predictions, we need to find evidence that these policies are significantly affected by hedging needs. We examine this issue in turn.

[22] Note that Shyam-Sunder and Myers do not consider contrasts between constrained and unconstrained firms. However, their sample selection scheme ensures that only large firms with rated debt enter the sample, hence their results can be compared with our debt regressions for unconstrained firms.

3.5 Debt and Cash Policies: Hedging Needs

The tests of this section consist of performing estimations of our 3SLS system across (double) partitions of constrained/unconstrained firms *and* firms with low/high hedging needs. Table 4 reports the results from those system estimations, separately for constrained firms (Panel A) and unconstrained firms (Panel B). The table features our first proxy for investment opportunities — that is, industry R&D expenditures — in the computation of the correlation between a firm's cash flows and the investment opportunities it faces. Table 5 is similarly compiled, but the results there employ our second measure of growth opportunities, industry sales growth. Finally, Table 6 presents the same sorts of regression outputs, but it employs changes in industry Q as the proxy for investment opportunities. For ease of exposition, we only present estimates of the cash flow sensitivities of cash and debt in the 3SLS system; that is, α_1 and β_1, respectively.

– insert Table 4 here –

– insert Table 5 here –

– insert Table 6 here –

Results in Tables 4 through 6 are all very similar. As in previous estimations, unconstrained firms display a strong, negative cash flow sensitivity of debt — they use their free cash flow to cut down debt — and their cash policies are completely insensitive to cash flow innovations. Importantly, these patterns are largely unrelated to measures of hedging needs. To be precise, the cash flow sensitivities of cash are insignificant for the vast majority of unconstrained firm subsamples (both those with low and those with high hedging needs). And while cash flow sensitivities of debt are sometimes more negative for firms with low hedging needs, the reverse pattern occurs with almost the same frequency. Overall, the estimates from regressions for unconstrained firms suggest that there is no systematic relation between hedging needs and either of the cash flow sensitivities.

The inferences are strikingly different for constrained firms. The results show that constrained firms with high hedging needs display the least negative cash flow sensitivities of debt — in fact, their net borrowing positions increase with cash flows — and they are also the ones doing the most cash savings. In contrast, constrained firms with low hedging needs display a tendency to reduce their outstanding debt when they have cash flow surpluses, a pattern that is similar (but weaker in magnitude) to that observed for unconstrained firms. In a handful of specifications (see Table 6), constrained firms with low hedging needs seem to have a propensity to save cash. But this pattern is far from robust. In Tables 4 and 5, for example, the cash flow sensitivities of cash are never significant for constrained firms with low hedging needs.

We also report the p-values of the differences in cash flow sensitivities of cash and debt within constrained and unconstrained subsamples (i.e., across hedging needs subsamples). One central pattern is clear, and independent of the specific correlation measure: constrained firms with high hedging needs have *higher* cash flow sensitivities of cash, and *less negative* cash flow sensitivities of debt than constrained firms with low hedging needs.

In all, the results from Tables 4 through 6 are fully consistent with the predictions of our model. Constrained firms do have a much stronger propensity to save cash out of cash flows, and a much weaker propensity to reduce debt when their hedging needs are high.[23] This pattern suggests that future investment needs, jointly with expectations about the availability of internal funds, are key determinants of these firms' financial policies. The fact that unconstrained firms do not display such patterns gives additional evidence that these patterns are indeed produced by the joint, dynamic optimization of financing and investment that characterizes constrained firms' policies.

4 Conclusion

We propose and test a theory of cash–debt substitutability in the presence of financing constraints. Our results show that cash cannot be treated as negative debt for constrained firms, particularly for those with high hedging needs. These firms prefer to allocate excess cash flows into cash holdings. In contrast, constrained firms with low hedging needs prefer to use excess cash flows towards reducing outstanding debt, thereby "saving" future borrowing capacity.

Our results suggest that there is an important hedging dimension to standard financial policies such as cash and debt management in the presence of financing frictions. While the link between hedging and financing constraints was previously identified by Froot et al. (1993), the implications of this link for cash and debt policies had hitherto not been studied. In looking at cash and debt balances as hedging devices, we find evidence of activities by real-world firms that are fully consistent with the theoretical link between hedging and financing constraints. Such a match between theory and evidence has often eluded those researchers who focus on the use of derivatives as hedging tools. We also identify an empirical counterpart for the notion of hedging demand. Based on the correlation between firm-level cash flows and industry-level investment opportunities, our study suggests various easy-to-implement measures of "hedging needs."

As we discuss in the Introduction, there are two possible characterizations of the view of "cash as negative debt." First, firms could simply be indifferent between having more cash or less debt in their balance sheets. Second, cash can be seen as the negative of debt when firms use cash to reduce debt. Our theory suggests that under the first characterization, cash can only be negative debt if firms are financially unconstrained and no other frictions cause firms to prefer negative debt over positive cash, and vice-versa. The existence of financial constraints, in particular, eliminates the

[23] Notice that the positive cash flow sensitivities of debt for firms with high hedging needs are consistent with the predictions of the model augmented by date 0 investment (cf. Section 2.3.2 and Appendix B).

indifference between cash and (negative) debt because these two components of a firm's financial structure have different implications for firms' feasible investment spending. Concerning the second characterization, our paper gives a more involved answer. Specifically, cash can be viewed as negative debt even for constrained firms if their hedging needs are low: these firms should display a preference towards using cash to reduce debt. In contrast, cash will not be used to reduce debt by constrained firms with high hedging needs. For these firms, the value of cash inside the firm is higher than when it is used to reduce debt.

Our analysis focused mostly on the substitution effect between cash and debt among financially constrained firms. However, our finding that financially unconstrained firms, too, display a systematic preference for using excess cash flows to reduce debt suggests that other considerations are at play in the data. These considerations could include, for example, issues such as the yield on cash relative to the firm's effective borrowing cost and the diversion of free cash flows by management. Future research should try to identify the effects of tax parameters, agency problems, and liquidity premiums, among others, on the use of financial policy to effect corporate hedging in general, and on the substitutability between cash and debt in particular.

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Appendix

A Proofs

Proof of Lemma 1

Consider (2) when that expression is an equality. Differentiating both sides with respect to I, we obtain

$$[1 - \tau g'(I)]I' = -1 + \frac{\partial}{\partial \Delta}\left[\tau c_2 - d_2^N\right]^+. \tag{15}$$

It is our maintained assumption that $[1 - \tau g'(I)]$ is greater than zero. From Eq. (7), if $\Delta > \widetilde{\Delta}$, then $\tau c_H > \tau c_L > d_2^N$ and $[\tau c_2 - d_2^N]^+ = \tau c_2 - D_0 + \Delta$. It follows that in this case, $I_H(\Delta)$ and $I_L(\Delta)$ are independent of Δ.

When $\Delta < \widetilde{\Delta}$, $\tau c_H \geq d_2^N > \tau c_L$. Hence, $[\tau c_H - d_2^N]^+ = \tau c_H - d_2 + \frac{\Delta}{p^*}$ and $[\tau c_L - d_2^N]^+ = 0$. It follows that in this case, $I_H(\Delta)$ is strictly increasing in Δ and $I_L(\Delta)$ is strictly decreasing in Δ.

Finally, note that for a given state s, $I_s^*(\Delta)$ is either equal to I^{FB}, which is independent of Δ, or equal to $I_s(\Delta)$. The lemma now follows from the properties of $I_s(\Delta)$ derived above. $\diamondsuit$

Proof of Proposition 1

We start the characterization of the optimal financial policy with the following lemma.

Lemma 2 *The firm is financially unconstrained if and only if it is unconstrained in state L when $\Delta = \Delta_{\min}$. Otherwise, it is financially constrained in the sense that there does not exist a Δ that allows the firm to invest at first-best levels in both states.*

Proof: From Eq. (2), note that for a given Δ, if the firm is unconstrained in state L, then

$$I^{FB} > c_0 - \Delta + \tau g(I^{FB}) + \left[\tau c_L - d_2^N\right]^+. \tag{16}$$

Since $c_H > c_L$, this inequality must also hold with c_L replaced by c_H, and in turn, the firm must be unconstrained in state H as well. Furthermore, from Lemma 1, $I_L^*(\Delta)$ is weakly decreasing in Δ. Hence, if the firm is unconstrained in state L at $\Delta = \Delta_{\min}$, then the firm is always financially unconstrained. $\diamondsuit$

This lemma is a straightforward implication of the fact that in terms of financing capacity the only (*ex post*) difference between state L and state H is that cash flows from existing assets are higher in state H. Consequently, the financing capacity in state H is always higher than in state L, for all possible Δ, which means that if the firm is financially unconstrained in state L, it must also be financially unconstrained in state H. Because state-L financing capacity is decreasing in Δ (see Lemma 1), a necessary and sufficient condition for the firm to be unconstrained is that the firm invests at the first-best level when financing capacity in state L is at its maximum.

We are now ready to prove Proposition 1. Consider first a firm that is financially unconstrained. From Lemma 2, when the firm is unconstrained, it must be unconstrained in state L at the lowest possible value of Δ, $I_L^*(\Delta_{\min}) = I^{FB}$. From Lemma 2, $I_L^*(\Delta)$ is weakly decreasing in Δ, so that for $\Delta > \Delta_{\min}$, $I_L^*(\Delta) \leq I_L^*(\Delta_{\min})$ and the firm may be rendered constrained if it becomes constrained in state L. Denote $\widehat{\Delta}$ as the minimum of $\Delta_{\max}$ and the maximum value of Δ for which $I_L^*(\Delta) = I^{FB}$. It follows that for $\Delta \in [\Delta_{\min}, \widehat{\Delta}]$, the firm is unconstrained and hence indifferent in picking any policy Δ. For $\Delta > \widehat{\Delta}$, the firm is rendered constrained in state L which can only reduce firm value.

Consider now a firm that is financially constrained for all Δ. In this case, the firm solves the maximization problem in (9) and $I_s^*(\Delta) = I_s(\Delta)$, the constrained investment levels given by (2). Consider first the effect of "small" increases in Δ, such that $\tau c_L < d_2^N$ after the debt repayment. In this case, the first-order condition for an interior solution of Δ is

$$(1-p)\left[\frac{p(1-q)}{(p+(1-p)q)}\,\frac{\phi(g_H' - 1)}{(1-\tau g_H')} - \frac{(1-\phi)(g_L' - 1)}{(1-\tau g_L')}\right] = 0,$$

where we have substituted the derivatives

$$\frac{\partial I_H}{\partial \Delta_0} = \frac{(1-p)(1-q)}{(p+(1-p)q)(1-\tau g_H')},$$

$$\frac{\partial I_L}{\partial \Delta_0} = -\frac{1}{(1-\tau g_L')}.$$

For any given Δ, we clearly have that $I_H \geq I_L$, and in turn, $g_H' \leq g_L'$, implying that

$$\frac{(g_H'-1)}{(1-\tau g_H')} \leq \frac{(g_L'-1)}{(1-\tau g_L')}.$$

Since $\frac{p(1-q)}{(p+(1-p)q)} < 1$, we obtain that for $\phi \leq 0.5$, the left hand side of the first-order condition is always negative, whereby $\Delta^* = \Delta_{\min}$. At $\phi = 1$, it is always positive whereby $\Delta^* = \min(\widetilde{\Delta}, \Delta_{\max})$. This last step follows from the fact that once the debt repayment is "large" (equal to $\widetilde{\Delta}$), the debt becomes riskless and a further increase in debt repayment does not affect the objective function. To see this, note that Eqs. (2) and (7) for $\tau c_L > d_2^N$ imply that

$$I_H = c_0 + \tau g(I_H) + \tau c_H - D_0 \tag{17}$$
$$I_L = c_0 + \tau g(I_L) + \tau c_L - D_0. \tag{18}$$

Next, we show that whenever Δ^* is interior, it is increasing in ϕ. Then, the existence of unique $\overline{\phi}$ and $\overline{\overline{\phi}}$ follows by the intermediate-value theorem.

Denoting the objective function in (9) by $f(\Delta)$, we obtain that at the optimal Δ^*,

$$\frac{\partial f}{\partial \Delta} = 0, \frac{\partial^2 f}{\partial \Delta^2} < 0.$$

By the implicit-function theorem, that is, taking derivative of the first order condition w.r.t. ϕ, we obtain

$$\text{sign}\left(\frac{d\Delta}{d\phi}\right) = \text{sign}\left(\frac{\partial^2 f}{\partial \phi \partial \Delta}\right).$$

Now,

$$\frac{\partial f}{\partial \Delta} = (1-p)\left[\frac{p(1-q)}{(p+(1-p)q)}\,\frac{\phi(g_H'-1)}{(1-\tau g_H')} - \frac{(1-\phi)(g_L'-1)}{(1-\tau g_L')}\right].$$

For future reference, define $\widehat{p} \equiv \frac{p(1-q)}{(p+(1-p)q)}$. Since $\widehat{p}$ multiplies the marginal productivity of investment at state H, a high $\widehat{p}$ raises the incentive to invest in that state, and thus the incentive to repay debt.

We have:

$$\frac{\partial^2 f}{\partial \phi \partial \Delta} = (1-p)\left[\widehat{p}\frac{(g_H'-1)}{(1-\tau g_H')} + \frac{(g_L'-1)}{(1-\tau g_L')}\right] \ > \ 0.$$

This completes the proof that $\frac{d\Delta}{d\phi} > 0.\Diamond$

In addition, we can show that Δ^* is increasing in p. To see this, we use the implicit-function theorem again:

$$\text{sign}\left(\frac{d\Delta}{dp}\right) = \text{sign}\left(\frac{\partial^2 f}{\partial p \partial \Delta}\right),$$

which is positive, since

$$\frac{\partial^2 f}{\partial p \partial \Delta} = (1-p)\left[\begin{array}{c} \frac{q(1-q)\phi}{(p^*)^2}\frac{(g_H'-1)}{(1-\tau g_H')} \\ -\left[\frac{\widehat{p}\phi\Delta^*(1-q)}{(p^*)^2(1-\tau g_H')^3}\right]\left[g_H''(1-\tau g_H') + \tau g_H''(g_H'-1)\right] \end{array}\right] \ > \ 0.$$

The first term in brackets arises from the fact that $\widehat{p}$ is increasing in p. The second term arises from the fact that for a given Δ^*, I_H is decreasing in p^* (and thus in both p and q). Thus, a high p increases the incentives to invest in state H, and raises Δ^*.

Similarly,

$$\text{sign}\left(\frac{d\Delta}{dq}\right) = \text{sign}\left(\frac{\partial^2 f}{\partial q \partial \Delta}\right),$$

which is equal to

$$\frac{\partial^2 f}{\partial q \partial \Delta} = (1-p)\left[\begin{array}{c} -\frac{p}{(p^*)^2}\frac{\phi(g_H'-1)}{(1-\tau g_H')} \\ -\left[\frac{\widehat{p}(1-p)\phi\Delta^*}{(p^*)^2(1-\tau g_H')^3}\right]\left[g_H''(1-\tau g_H') + \tau g_H''(g_H'-1)\right] \end{array}\right],$$

which cannot generally be signed. The first term in the brackets is negative because $\widehat{p}$ decreases in q. However, the second term is positive because I_H is decreasing in p^*.

Proof of Proposition 2

For $\phi \leq \frac{1}{2}$, $\Delta^* = \Delta_{\min}$, which is independent of c_0. Since $c_1 = c_0 - \Delta$, it follows that for $\phi \leq \frac{1}{2}$, $\frac{\partial c_1}{\partial c_0} > 0$ and $\frac{\partial \Delta}{\partial c_0} = 0$.

For $\phi \geq \overline{\overline{\phi}}$, $\Delta^* = \min(\widetilde{\Delta}, \Delta_{\max})$. Since $\widetilde{\Delta}$ is independent of c_0 and $\Delta_{\max} = \min(c_0, D_0)$ is weakly increasing in c_0, we obtain that for $\frac{\partial \Delta}{\partial c_0} > 0$. When the relevant parameter range is $\Delta^* = c_0$, then we also obtain that $\frac{\partial c_1}{\partial c_0} = 0$. $\diamondsuit$

B Date 0 Investments

We modify the basic model of Section 2.2 by assuming that instead of the exogenously given cash flow c_2, the firm produces the cash flow c_2 from an investment I_0 that is made at date 0. We assume that $\tau^C = 0$, as in Section 2.2. In addition, to simplify the notation we assume in this extension that $q = 0$, that is, if state L is reached the firm is in default with probability equal to one.

Investment of I_0 units at date 0 produces a high cash flow equal to $c_H f(I_0)$ in state H, and $c_L f(I_0)$ in state L. Denote $\hat{c} = pc_H + (1-p)c_L$, and set $g(I) \equiv \hat{c} f(I)$ for all I, so that average investment opportunities are constant over time. In addition, and without loss of generality, we normalize $\hat{c}$ to 1.

The firm's problem at date 0 is now to pick cash reserves (c_1) and an amount of debt to issue (whose face value we denote by d_2) to maximize firm value, given its current amount of internal funds c_0, and its investment opportunities today and tomorrow.

We make a few additional tractability assumptions. First, we assume that debt capacity is linear in the level of investments. Thus, the date-1 investments generate debt capacity equal to τI_H and τI_L, respectively, in states H and L. Next, We also assume that the debt capacity generated by date-0 investment is correlated with the level of cash flows. Thus, in state H (L), the firm can pledge a total of $\tau c_H I_0$ ($\tau c_L I_0$). These assumptions greatly simplify the calculations below, because they allow us to express the investment levels as explicit linear functions of c_1 and d_2. The assumptions can be justified by a model in which investment cash flows are not pledgeable, but in which underlying assets can be liquidated by creditors (see also Almeida et al. (2004)).[24]

With these assumptions, if we denote the market value of debt as D_0, then

$$D_0(d_2) = p \min[d_2, \tau c_H I_0] + (1-p) \min[d_2, \tau c_L I_0].$$

The firm's optimization problem is thus given by

$$\max_{c_1, d_2} \quad [g(I_0) - I_0] + p\phi \, [g(I_H) - I_H] + (1-p)(1-\phi) \, [g(I_L) - I_L] \tag{19}$$

subject to the financing constraints:

$$\begin{aligned} I_0 + c_1 &\leq c_0 + D_0(d_2), && (20) \\ I_H &\leq c_1 + \tau I_H + [\tau c_H I_0 - d_2]^+, \text{ and} && (21) \\ I_L &\leq c_1 + \tau I_L + [\tau c_L I_0 - d_2]^+. && (22) \end{aligned}$$

Notice that the firm's cash and debt policies, c_1 and d_2, respectively, fully determine current and future investment. As in the basic model, if the firm is financially unconstrained its financial policy is irrelevant, so we focus on constrained firms.

The constrained firm's trade-off between cash and debt can now be formulated in the following way. Issuing more debt allows the firm to invest more at date 0, and/or to hold more cash (see constraint (20) above). However, debt decreases financing capacity in the future, since debtholders will capture the pledgeable cash flows from the date 0 investment, cash flows that can alternatively be used to raise additional financing at date 1 (see constraints (21) and (22) above). As in the basic model, an increase in debt has a particularly large effect on investment in the good state of the world (I_H), since debt repayment will be concentrated in such states. Because higher debt can be compensated by higher cash balances, a financial policy that entails high cash and high debt will transfer resources to state L, while low cash and low debt transfer resources to state H.

Proposition 1-A *The optimal financial policy of the constrained firm* (d_2^*, c_1^*) *depends on the correlation between cash flows and investment opportunities as follows:*

[24] In other words, the cash flows $f(.)$ and $g(.)$ generate zero pledgeability, but the physical investments I_0 and I_1 can be liquidated by creditors. The price of the physical assets (including the non-pledgeable part) in this formulation is equal to c_2 at date 1, and equal to 1 at date 2.

- *If $\phi \leq \frac{1}{2}$, the optimal policy of the firm is to issue as much debt as possible, that is:*

$$d_2^* = \tau c_H I_0$$

and to choose an interior solution for optimal cash balances, that is:

$$0 < c_1^* < c_0. \tag{23}$$

- *If $\phi > \frac{1}{2}$, it is optimal for the firm to issue less debt than the maximum, that is, $d_2^* < \tau c_H f$. The optimal cash balances are also as in Eq. (23). In addition, c_1^* is decreasing with ϕ in this range. Assuming that $g^{''}$ is equal to a constant, a sufficient condition for d_2^* to be decreasing with ϕ is that the firm is sufficiently constrained, that is, that the pledgeability parameter τ be smaller than a threshold, $\tau^*(\phi) > 0$.*

Proof: The first order conditions of program (19) with respect to c_1 and d_2 can be respectively written as:

$$\left[g_0^{'} - 1\right]\frac{\partial I_0}{\partial c_1} + p\phi\left[g_H^{'} - 1\right]\frac{\partial I_H}{\partial c_1} + (1-p)(1-\phi)\left[g_L^{'} - 1\right]\frac{\partial I_L}{\partial c_1} = 0, \text{and} \tag{24}$$

$$\left[g_0^{'} - 1\right]\frac{\partial I_0}{\partial d_2} + p\phi\left[g_H^{'} - 1\right]\frac{\partial I_H}{\partial d_2} + (1-p)(1-\phi)\left[g_L^{'} - 1\right]\frac{\partial I_L}{\partial d_2} = 0, \tag{25}$$

Notice that under the assumption that the optimal debt level is risky (paid fully in state H but not in state L), we obtain:

$$\begin{aligned} I_0 &= \frac{1}{k}c_0 + \frac{p}{k}d_2 - \frac{1}{k}c_1 \\ I_L &= \frac{1}{1-\tau}c_1 \\ I_H &= \frac{\tau c_H}{k(1-\tau)}c_0 - \frac{1}{k}d_2 + \frac{k - \tau c_H}{k(1-\tau)}c_1 \end{aligned}$$

where $k \equiv 1 - (1-p)\tau c_L = 1 - \tau + \tau p c_H$. Notice this condition also assumes that $\tau c_H I_0 - d_2 > 0$. If $\tau c_H I_0 - d_2 = 0$, then we have that $I_L = I_H = \frac{1}{1-\tau}c_1$, and $I_0 = \frac{c_0 - c_1}{1-\tau}$.

These equations can be manipulated to yield the intuitive condition that the firm should try to equalize the marginal productivity of investment today with the marginal productivities of the two states tomorrow:

$$g_0' - 1 = \phi(g_H' - 1) = (1-\phi)(g_L' - 1)\ . \tag{26}$$

The firm sets its cash and debt policies so that investments can be as close as possible to the levels implied by condition (26). We characterize the solution for all ϕ, starting with $\phi \leq \frac{1}{2}$.

Case with $\phi \leq \frac{1}{2}$: Notice from Eqs. (21) and (22) that $I_H \geq I_L$ for all (c_1, d_2), and thus $(g_H' - 1) < (g_L' - 1)$. Furthermore, for any $d_2 < \tau c_H I_0$, we have $I_H > I_L$. Thus, for all $\phi \leq \frac{1}{2}$, it is optimal for the firm not to leave any spare debt capacity in state H, that is, $d_2^* = \tau c_H I_0$. This implies that $I_H^* = I_L^*$ for any c_1.

If $\phi = \frac{1}{2}$, this allows the firm to equalize marginal productivities of investment across future states. If $\phi < \frac{1}{2}$, the firm would actually like to have $I_H^* < I_L^*$, but this is impossible to achieve using only cash and debt in the way that we specified. For example, if $\phi = 0$, the firm will end up having c_1 in state H, without any use for it (it will pay a dividend according to our assumptions).

Summarizing this, we have that $d_2^* = \tau c_H I_0$ for all $\phi \leq \frac{1}{2}$. This implies that $I_H^* = I_L^* = I_1$ for all c_1. The optimal amount of cash is then determined according to the following program:

$$\max_{c_1}\ g(I_0) - I_0 + [p\phi + (1-p)(1-\phi)][g(I_1) - I_1] \text{ s.t.} \tag{27}$$

$$\begin{aligned} I_0 &= \frac{c_0 - c_1}{1-\tau} \\ I_1 &= \frac{c_1}{1-\tau} \end{aligned}$$

This problem is similar to the one solved in Almeida et al. (2004). The solution yields an optimal level of cash balances c_1^*, that equalizes the marginal productivities of investment over time. In particular, we must have that $0 < c_1^* < c_0$. Notice that if $c_1^* = 0$, $I_1 = 0$, and if $c_1^* = c_0$, $I_0 = 0$. Given the concavity of the production function $g(.)$, and given our assumption that $\hat{c}f_0(I) = g(I)$ for all I, these cannot be optimal solutions.

Case with $\phi > \frac{1}{2}$: In this case, it is optimal to save some debt capacity in state H, such that the firm can have $I_H^* \geq I_L^*$. We can write the first order conditions in (26) as a system of two equations in terms of the endogenous variables c_1 and d_2:

$$g'\left(\frac{1}{k}c_0 + \frac{p}{k}d_2 - \frac{1}{k}c_1\right) - 1 = (1-\phi)\left[g'\left(\frac{1}{1-\tau}c_1\right) - 1\right], \quad (28)$$

$$\phi\left[g'\left(\frac{\tau c_H}{k(1-\tau)}c_0 - \frac{1}{k}d_2 + \frac{k-\tau c_H}{k(1-\tau)}c_1\right) - 1\right] = (1-\phi)\left[g'\left(\frac{1}{1-\tau}c_1\right) - 1\right].$$

In order to find the derivatives $\frac{\partial d_2}{\partial \phi}$ and $\frac{\partial c_1}{\partial \phi}$ we need to differentiate this system of equations with respect to ϕ and solve for the values of $\frac{\partial d_2}{\partial \phi}$ and $\frac{\partial c_1}{\partial \phi}$. We have

$$\begin{bmatrix} \frac{g_0^{''}p}{k} & -\frac{g_0^{''}}{k} - \frac{(1-\phi)g_L^{''}}{(1-\tau)} \\ -\frac{\phi g_H^{''}}{k} & \frac{\phi g_H^{''}(k-\tau c_H)}{k(1-\tau)} - \frac{(1-\phi)g_L^{''}}{(1-\tau)} \end{bmatrix} \begin{bmatrix} \frac{\partial d_2}{\partial \phi} \\ \frac{\partial c_1}{\partial \phi} \end{bmatrix} = \begin{bmatrix} -(g_L^{'}-1) \\ -(g_L^{'}-1) - (g_H^{'}-1) \end{bmatrix}.$$

The 2×2 matrix that multiplies the vector of derivatives is the matrix of second derivatives (the Hessian) of the optimization problem. Thus, it must be negative definite. Using this fact, Cramer's rule implies that:

$$sgn(\frac{\partial c_1}{\partial \phi}) = -sgn\left[-\frac{g_0^{''}p}{k}[(g_L^{'}-1) + (g_H^{'}-1)] - \frac{\phi g_H^{''}}{k}(g_L^{'}-1)\right] < 0$$

and:

$$sgn(\frac{\partial d_2}{\partial \phi}) = -sgn\left[\begin{array}{c} [-\frac{g_0^{''}}{k} - \frac{(1-\phi)g_L^{''}}{(1-\tau)}][(g_L^{'}-1) + (g_H^{'}-1)] - \\ (g_L^{'}-1)[\frac{\phi g_H^{''}(k-\tau c_H)}{k(1-\tau)} - \frac{(1-\phi)g_L^{''}}{(1-\tau)}] \end{array}\right]$$

A sufficient condition for $\frac{\partial d_2}{\partial \phi} < 0$ is that $\frac{\phi g_H^{''}(k-\tau c_H)}{k(1-\tau)} - \frac{(1-\phi)g_L^{''}}{(1-\tau)} < 0$. If $g_H^{''} = g_L^{''} =$ constant, this requires that:

$$\phi(k - \tau c_H) - k(1-\phi) > 0$$

Recall that $k \equiv 1 - (1-p)\tau c_L$. Thus, if τ is small enough (and given that $\phi > \frac{1}{2}$), this condition will hold. Formally, τ needs to be smaller than $\hat{\tau}(\phi) \equiv \frac{1}{[\frac{\phi}{(2\phi-1)}c_H + (1-p)c_L]}$, which is increasing in ϕ. In addition, notice that this expression is more likely to be positive if ϕ is large, and recall that if $\phi = \frac{1}{2}$, then debt is at a corner solution in which the firm issues as much debt as possible. Thus, even if the expression above for $\frac{\partial d_2}{\partial \phi}$ is positive for ϕ very close to $\frac{1}{2}$, the firm will not be able to issue more debt than $\tau c_H I_0$ and we will obtain $\frac{\partial d_2}{\partial \phi} = 0$ as in the $\phi = \frac{1}{2}$. Thus, we conclude that $\frac{\partial d_2}{\partial \phi} \leq 0$ for all $\phi > \frac{1}{2}$, if τ is sufficiently small.$\diamondsuit$

The intuition for this result is similar to that in Proposition 1. If the firm needs resources mostly in state H (i.e., if ϕ is high), it will prefer to carry less debt and hold less cash. In contrast, if ϕ is low, the firm will prefer to carry more cash and issue less debt at date 0. The additional result in this extension is that the firm must also balance the marginal productivity of investment over time. However, because cash savings and debt have opposing effects on date 0 investment, the firm can generally achieve inter-temporal smoothing under either alternative (high cash/high debt, or low cash/low debt). The conclusion is that even with date 0 investment, the financial policy of the constrained firm will depend mostly on the correlation between cash flows and investment opportunities (the parameter ϕ).

Some observations are in order. If ϕ is large enough, it might happen that the optimal d_2^* that equates marginal productivities falls below $\tau c_L f_0$ (debt becomes riskless). If this is the case, then cash is equal to negative debt in a "marginal" sense, in the sense that a small increase in c_0 could be randomly allocated to either cash or debt without changing current and future investments. Note however that even in this case cash is not negative debt in a global sense, since the constrained firm's policy of having extremely low debt is an optimal response to the need to save debt capacity for future good states of the world. Furthermore, if $d_2^* < 0$ (which is possible), then the firm will not be able to transfer as many resources as it wants to state H. The optimal policy in this case is to make $d_2^* = 0$, and $c_1^* = 0$.

Finally, this extension also produces comparative statics that are similar (but not identical) to those characterized in Proposition 2.

Proposition 2-A *Suppose the firm is financially constrained. Then, we obtain the following effects on the firm's cash and debt policies from a variation in the availability of internal funds, c_0:*

- *If the correlation between cash flows and investment opportunities is low ($\phi \leq \frac{1}{2}$), then an increase in c_0 increases the firm's cash balances ($\frac{\partial c_1^*}{\partial c_0} > 0$), and the amount of debt outstanding ($\frac{\partial d_2^*}{\partial c_0} > 0$).*

- *If the correlation between cash flows and investment opportunities is high ($\phi = 1$) then an increase in c_0 has no effect on the firm's cash balances ($\frac{\partial c_1^*}{\partial c_0} = 0$), and provided the firm is sufficiently constrained, that is, the pledgeability parameter τ is smaller than a threshold, $\tau^{**} > 0$, it decreases the amount of debt outstanding ($\frac{\partial d_2^*}{\partial c_0} < 0$).*

Proof: Take first the case in which $\phi \leq \frac{1}{2}$ (high hedging needs). As explained above, we have $d_2^* = \tau c_H I_0$ in this case. Therefore:

$$\frac{\partial d_2^*}{\partial c_0} = \tau c_H \frac{\partial I_0}{\partial c_0} > 0$$

Thus, in this extension the cash flow sensitivity of debt is positive for firms with very high hedging needs. The intuition is that high cash flows allow the firm to invest more, and because debt capacity is linked to investment returns, the firm can also borrow a greater amount at date 0 (a multiplier effect). In addition, as we argued above the cash policy in this case is determined by program (27). It can be shown that $\frac{\partial c_1^*}{\partial c_0} > 0$ in this case (see Almeida et al. for a proof). Thus, if hedging needs are high the cash flow sensitivity of cash is positive (as in Proposition 2), but the cash flow sensitivity of debt is also positive. With date 0 investments, not only it is the case that firms are unlikely to use cash flows to reduce outstanding debt, but they might actually display a positive correlation between cash flows and debt due to the multiplier effect.

Consider now the case in which $\phi = 1$. In this case, the constrained firm would ideally like to make $I_H = I_0$, and $I_L = 0$ since there is no valuable investment in state L. One way not to have any resources available in state L is to make $c_1^* = 0$, and $d_2^* \geq \tau c_L I_0$. In order to make $I_H = I_0$ the firm would then set d_2 such that:

$$\frac{1}{k}c_0 + \frac{p}{k}d_2 = \frac{\tau c_H}{k(1-\tau)}c_0 - \frac{1}{k}d_2$$

This gives:

$$d_2^* = -\frac{(1-\tau-\tau c_H)}{(1-\tau)}c_0 \tag{29}$$

Thus, we have that $\frac{\partial c_1^*}{\partial c_0} = 0$, and $\frac{\partial d_2^*}{\partial c_0} < 0$ if $(1-\tau-\tau c_H) > 0$, that is, if τ is small enough, in particular, smaller than $\tau^{**} \equiv \frac{1}{(1+c_H)}$. $\diamondsuit$

C Other Costs and Benefits of Cash and Debt

We introduce a parameter k to capture in a simplified way other (net) costs and benefits of cash and debt. We assume that holding a unit of cash for a period yields a return of $(1-k)$ next period. For example, given the level of cash retained in period 0, $c_1 = c_0 - \Delta$, the cash available for the firm in period 1 is $(1-k)c_1$. If, for example, cash has a low yield as a consequence of its liquidity, the parameter k would be positive. Variables that favor debt issues and cash retention (possibly related to tax considerations) could be captured by a negative k.

C.1 Solution when $k > 0$

Unconstrained Firms

A cost of holding cash means that unconstrained firms will no longer be indifferent between holding cash and repaying debt. In fact, it becomes optimal for such firms to carry as little cash as possible, given that cash does not increase investment for such firms.

In order to show this, we start by characterizing optimal decisions at date 1, for a given Δ. For a given Δ, the firm has an amount of cash equal to $(1-k)(c_0-\Delta)$ available at that date. In the states in which there is no investment opportunity, the optimal strategy is to pay out this cash so that the firm does not carry it again into period 2. In the states in which there is an investment opportunity, it is optimal for unconstrained firms to issue as little debt as possible, so that less cash is carried into period 2. Given that the unconstrained firm invests I^{FB} if there is an investment opportunity, and given the firm's budget constraint at date 1, we have that the optimal debt issue B_1^* in states in which there is an investment opportunity satisfies

$$I^{FB} = (1-k)(c_0-\Delta) + B_1^*.$$

If $B_1 = B_1^*$, the firm carries no cash from date 1 to date 2 in states in which an investment opportunity arises. Given these date 1 decisions, the firm's expected equity value at date 0 can be written as

$$\begin{aligned}
&p\phi[c^H + g(I^{FB}) - B_1^* - d_2^N] + p(1-\phi)[c^H + (1-k)(c_0-\Delta) - d_2^N] + \\
&(1-p)\phi\left[(1-q)\left[c^L + (1-k)(c_0-\Delta) - \tau c^L\right] + q\left[c^H + (1-k)(c_0-\Delta) - d_2^N\right]\right] + \\
&(1-p)(1-\phi)\left[(1-q)[c^L + g(I^{FB}) - B_1^* - \tau c^L] + q[c^H + g(I^{FB}) - B_1^* - d_2^N]\right].
\end{aligned}$$

The firm's objective is to choose Δ to maximize this expression, an optimization problem which using the definition of B_1^* and the relationship between d_2^N and Δ can be written as

$$\max_{\Delta}[\Delta + (1-k)(c_0 - \Delta)].$$

Clearly, as long as $k > 0$, and conditional on the firm being unconstrained the firm benefits from increasing Δ as much as possible. Thus, the optimal solution for Δ, Δ^*, is such that:

$$\Delta^* \geq \widehat{\Delta} = \min(\Delta_{\max}, \Delta^{'}),$$

where $\Delta^{'}$ is the value of Δ that renders the firm constrained in state L. $\Delta^{'}$ satisfies:

$$\Delta^{'} = c_0 - \frac{[I^{FB} - \tau g(I^{FB})]}{(1-k)}.$$

If $\Delta^{'} < \Delta_{\max}$, we cannot guarantee that $\Delta^* = \Delta^{'}$ exactly. The problem is that it might be worthwhile for the firm to become somewhat constrained in state L given the benefit of reducing debt and carrying less cash. The optimal value of Δ is somewhere between $\Delta^{'}$ and $\Delta_{\max}$. In any case, we have the result that the cash flow sensitivity of debt should be negative in this case. Both $\Delta^{'}$ and $\Delta_{\max}$ are increasing with c_0, and thus an increase in c_0 reduces the amount of debt that the firm carries into the future.

The intuition for the sensitivity result is simple. An increase in cash flow either allows the firm to repay more debt directly, or indirectly through a relaxation of the financial constraint in state L, in case the constraint becomes binding. Notice also that even though we have a negative relationship between cash flow and debt for unconstrained firms in this case, this relationship should hold irrespective of the correlation between cash flows and investment opportunities (Δ^* is independent of ϕ).

Constrained Firms

The introduction of a cost of holding cash does not change the qualitative nature of the results obtained for the constrained firms. First, for constrained firms that choose to repay debt when $k = 0$, there is obviously no change in behavior. Second, because the cost of carrying cash increases, the only change in the result characterized in Proposition 1 is that the threshold $\overline{\phi}$ below which it is optimal for the constrained firm not to repay any debt should be lower, and decreasing with k.

C.2 Solution when $k < 0$

Unconstrained Firms

A negative cost of carrying cash translates into a benefit of allowing debt to be as high as possible, with the additional proceeds parked in the cash account. A similar reasoning to that described above shows that the unconstrained firm benefits from issuing debt at date 0, that is:

$$\Delta^* = \Delta_{\min}.$$

By definition, the firm can only be unconstrained if it is unconstrained in state L when $\Delta = \Delta_{\min}$, so now there is a uniquely optimal value for Δ.

Since $c_1 = c_0 - \Delta_{\min}$ for such firms, we get the implication that an increase in cash flow should result in higher cash savings for unconstrained firms. Notice that $\Delta_{\min}$ is independent of cash flow. Again, this implication is independent of the correlation between cash flows and investment opportunities.

Constrained Firms

As in the analysis of the previous case, there is no qualitative change in the implications for constrained firms. The only change is that the threshold above which the firm finds it profitable to repay debt in Proposition 1 will increase.

Table 1: Constraint Type Cross-Correlations

This table displays constraint type cross-classifications for the four criteria used to categorize firm-years as either financially constrained or unconstrained (see text for full details). To ease visualization, we assign the letter (C) for constrained firms and (U) for unconstrained firms in each row/column. All data are from the annual COMPUSTAT industrial tapes and the sample period is 1971 through 2001.

Financial Constraints Criteria		Payout Policy		Firm Size		Bond Ratings		CP Ratings	
		(C)	(U)	(C)	(U)	(C)	(U)	(C)	(U)
1. Payout Policy									
Constrained Firms	(C)	6,153							
Unconstrained Firms	(U)		6,231						
2. Firm Size									
Constrained Firms	(C)	2,680	1,221	6,060					
Unconstrained Firms	(U)	1,078	2,645		6,231				
3. Bond Ratings									
Constrained Firms	(C)	2,605	2,190	4,217	922	7,953			
Unconstrained Firms	(U)	3,548	4,041	1,843	5,309		12,193		
4. Commercial Paper Ratings									
Constrained Firms	(C)	4,920	3,229	5,763	1,781	7,689	5,254	12,943	
Unconstrained Firms	(U)	1,233	3,002	297	4,450	264	6,939		7,203

Table 2: Summary Statistics for Financial Constrainsts and Hedging Needs

This table displays summary statistics for beginning-of-period long-term debt (*Debt*), beginning-of-period holdings of cash and liquid securities (*CashHold*), current cash flows (*CashFlow*), market-to-book asset ratio (*Q*), unleveraged Altman's *Z-score*, and net debt issuance ($\Delta Debt$) across groups of financially constrained and unconstrained firms and firms with high versus low hedging needs. Hedging needs are measured based on the correlation between a firm's cash flow and various industry-level proxies for investment opportunities (these alternative measures are used in Panels A through C). All data are from the annual COMPUSTAT industrial tapes and the sample period is 1971 through 2001.

Panel A: Hedging needs based on the correlation between firm cash flows and industry R&D

		Variable Mean [Median]					
		Debt	*CashHold*	*CashFlow*	*Q*	*Z-Score*	$\Delta Debt$
Financial Constraints Criteria	Hedging Needs						
1. Payout Policy							
Constrained Firms	High Hedging Needs (N= 2,537)	0.1968 [0.1791]	0.1337 [0.0830]	0.0201 [0.0329]	1.5284 [1.1906]	2.0386 [2.1758]	0.0111 [−0.0008]
	Low Hedging Needs (N= 1,585)	0.2135 [0.1991]	0.1447 [0.0990]	0.0320 [0.0385]	1.6361 [1.2541]	2.0692 [2.1354]	0.0096 [−0.0019]
Unconstrained Firms	High Hedging Needs (N= 2,459)	0.1686 [0.1590]	0.0845 [0.0564]	0.0186 [0.0161]	1.3758 [1.1408]	2.4610 [2.4076]	0.0133 [−0.0001]
	Low Hedging Needs (N= 1,467)	0.1703 [0.1672]	0.0976 [0.0601]	0.0242 [0.0228]	1.5985 [1.1802]	2.4272 [2.3867]	0.0164 [0.0000]
2. Firm Size							
Constrained Firms	High Hedging Needs (N= 2,468)	0.1478 [0.1189]	0.1710 [0.1352]	0.0315 [0.0426]	1.5817 [1.3050]	2.6141 [2.7545]	0.0095 [−0.0023]
	Low Hedging Needs (N= 1,574)	0.1494 [0.1229]	0.1787 [0.1238]	0.0414 [0.0450]	1.6500 [1.2693]	2.5550 [2.6696]	0.0063 [−0.0030]
Unconstrained Firms	High Hedging Needs (N= 2,427)	0.1771 [0.1671]	0.0743 [0.0525]	0.0196 [0.0202]	1.3420 [1.1307]	2.1383 [2.1401]	0.0119 [0.0006]
	Low Hedging Needs (N= 1,545)	0.1868 [0.1828]	0.0938 [0.0699]	0.0324 [0.0305]	1.6882 [1.2715]	2.1742 [2.2180]	0.0125 [0.0016]
3. Bond Ratings							
Constrained Firms	High Hedging Needs (N= 3,351)	0.1492 [0.1334]	0.1334 [0.0940]	0.0301 [0.0342]	1.4189 [1.1470]	2.6305 [2.6839]	0.0075 [−0.0018]
	Low Hedging Needs (N= 2,294)	0.1536 [0.1400]	0.1371 [0.0947]	0.0367 [0.0365]	1.5030 [1.1556]	2.5729 [2.6157]	0.0080 [−0.0019]
Unconstrained Firms	High Hedging Needs (N= 4,576)	0.1908 [0.1771]	0.0861 [0.0573]	0.0266 [0.0290]	1.4598 [1.2147]	2.2460 [2.2777]	0.0141 [0.0000]
	Low Hedging Needs (N= 2,754)	0.2032 [0.1894]	0.1020 [0.0694]	0.0360 [0.0370]	1.7106 [1.3326]	2.1966 [2.2066]	0.0150 [0.0000]
4. Commercial Paper Ratings							
Constrained Firms	High Hedging Needs (N= 5,124)	0.1788 [0.1632]	0.1245 [0.0832]	0.0255 [0.0305]	1.3877 [1.1457]	2.4129 [2.4785]	0.0110 [−0.0015]
	Low Hedging Needs (N= 3,391)	0.1854 [0.1707]	0.1296 [0.0870]	0.0346 [0.0354]	1.5131 [1.1864]	2.3557 [2.4188]	0.0111 [−0.0013]
Unconstrained Firms	High Hedging Needs (N= 2,803)	0.1654 [0.1553]	0.0740 [0.0528]	0.0328 [0.0322]	1.5428 [1.2656]	2.4022 [2.3766]	0.0119 [0.0000]
	Low Hedging Needs (N= 1,657)	0.1735 [0.1673]	0.0952 [0.0692]	0.0397 [0.0394]	1.8272 [1.4117]	2.3947 [2.3262]	0.0134 [0.0004]

Table 2: — Continued

PANEL B: HEDGING NEEDS BASED ON THE CORRELATION BETWEEN FIRM CASH FLOWS AND INDUSTRY SALES GROWTH

		Variable Mean [Median]					
		Debt	*CashHold*	*CashFlow*	*Q*	*Z-Score*	*ΔDebt*
FINANCIAL CONSTRAINTS CRITERIA	HEDGING NEEDS						
1. PAYOUT POLICY							
Constrained Firms	High Hedging Needs	0.2118	0.1338	0.0201	1.5537	2.0189	0.0114
	(N= 2,039)	[0.1909]	[0.0860]	[0.0357]	[1.2017]	[2.1566]	[−0.0016]
	Low Hedging Needs	0.2137	0.1572	0.0233	1.6970	1.9567	0.0142
	(N= 1,622)	[0.1886]	[0.0979]	[0.0326]	[1.2807]	[2.0396]	[−0.0010]
Unconstrained Firms	High Hedging Needs	0.1834	0.0860	0.0202	1.3779	2.3732	0.0140
	(N= 2,127)	[0.1782]	[0.0580]	[0.0179]	[1.1609]	[2.3169]	[0.0000]
	Low Hedging Needs	0.1685	0.0944	0.0218	1.6206	2.4605	0.0154
	(N= 1,510)	[0.1596]	[0.0619]	[0.0221]	[1.1922]	[2.3971]	[0.0000]
2. FIRM SIZE							
Constrained Firms	High Hedging Needs	0.1493	0.1629	0.0343	1.5772	2.5916	0.0080
	(N= 2,276)	[0.1253]	[0.1193]	[0.0434]	[1.2775]	[2.7400]	[−0.0032]
	Low Hedging Needs	0.1518	0.1879	0.0344	1.7570	2.4955	0.0098
	(N= 1,579)	[0.1190]	[0.1423]	[0.0409]	[1.3342]	[2.6032]	[−0.0023]
Unconstrained Firms	High Hedging Needs	0.2106	0.0737	0.0215	1.3881	2.0033	0.0128
	(N= 2,107)	[0.2059]	[0.0506]	[0.0231]	[1.1572]	[2.0264]	[0.0013]
	Low Hedging Needs	0.1737	0.0879	0.0286	1.6739	2.2410	0.0132
	(N= 1,428)	[0.1661]	[0.0573]	[0.0285]	[1.2668]	[2.2474]	[0.0000]
3. BOND RATINGS							
Constrained Firms	High Hedging Needs	0.1486	0.1309	0.0329	1.4314	2.5899	0.0073
	(N= 2,980)	[0.1364]	[0.0971]	[0.0359]	[1.1559]	[2.6736]	[−0.0021]
	Low Hedging Needs	0.1543	0.1495	0.0324	1.5466	2.5159	0.0087
	(N= 2,196)	[0.1371]	[0.1007]	[0.0334]	[1.1721]	[2.5257]	[−0.0016]
Unconstrained Firms	High Hedging Needs	0.2114	0.0883	0.0268	1.4835	2.1873	0.0156
	(N= 3,801)	[0.2024]	[0.0566]	[0.0305]	[1.2399]	[2.1511]	[0.0000]
	Low Hedging Needs	0.2047	0.0969	0.0319	1.7057	2.2320	0.0155
	(N= 2,836)	[0.1857]	[0.0620]	[0.0356]	[1.3328]	[2.2763]	[0.0000]
4. COMMERCIAL PAPER RATINGS							
Constrained Firms	High Hedging Needs	0.1822	0.1229	0.0278	1.4249	2.3533	.0115
	(N= 4,643)	[0.1658]	[0.0851]	[0.0325]	[1.1595]	[2.4489]	[−0.0016]
	Low Hedging Needs	0.1916	0.1339	0.0285	1.5156	2.3326	0.0125
	(N= 3,392)	[0.1733]	[0.0853]	[0.0314]	[1.1828]	[2.3779]	[−0.0011]
Unconstrained Firms	High Hedging Needs	0.1892	0.0739	0.0332	1.5380	2.3922	0.0129
	(N= 2,138)	[0.1831]	[0.0516]	[0.0337]	[1.3102]	[2.2707]	[0.0000]
	Low Hedging Needs	0.1674	0.0923	0.0396	1.8858	2.4063	0.0126
	(N= 1,640)	[0.1535]	[0.0618]	[0.0407]	[1.4789]	[2.4018]	[0.0000]

Table 2: — Continued

PANEL C: HEDGING NEEDS BASED ON THE CORRELATION BETWEEN FIRM CASH FLOWS AND INDUSTRY Q

		Variable Mean [Median]					
		Debt	*CashHold*	*CashFlow*	*Q*	*Z-Score*	*ΔDebt*
FINANCIAL CONSTRAINTS CRITERIA	HEDGING NEEDS						
1. PAYOUT POLICY							
Constrained Firms	High Hedging Needs (N= 1,661)	0.2295 [0.2053]	0.1272 [0.0781]	0.0191 [0.0303]	1.5121 [1.1693]	1.9925 [2.0887]	0.0105 [–0.0018]
	Low Hedging Needs (N= 1,288)	0.1944 [0.1625]	0.1657 [0.1156]	0.0262 [0.0338]	1.7417 [1.2919]	1.9896 [2.0932]	0.0119 [–0.0027]
Unconstrained Firms	High Hedging Needs (N= 1,661)	0.1865 [0.1821]	0.0842 [0.0547]	0.0147 [0.0139]	1.3053 [1.0686]	2.3894 [2.3538]	0.0146 [0.0000]
	Low Hedging Needs (N= 1,041)	0.1724 [0.1644]	0.0934 [0.0570]	0.0270 [0.0271]	1.5417 [1.2261]	2.5325 [2.5383]	0.0174 [0.0000]
2. FIRM SIZE							
Constrained Firms	High Hedging Needs (N= 1,631)	0.1637 [0.1414]	0.1620 [0.1160]	0.0347 [0.0414]	1.5684 [1.2532]	2.6271 [2.7018]	0.0080 [–0.0034]
	Low Hedging Needs (N= 1,638)	0.1469 [0.1122]	0.1789 [0.1382]	0.0414 [0.0457]	1.7364 [1.3621]	2.5776 [2.7309]	0.0073 [–0.0027]
Unconstrained Firms	High Hedging Needs (N= 1,730)	0.2071 [0.2003]	0.0702 [0.0466]	0.0178 [0.0202]	1.2892 [1.0887]	2.0687 [2.0809]	0.0129 [0.0009]
	Low Hedging Needs (N= 808)	0.1862 [0.1707]	0.0769 [0.0493]	0.0300 [0.0328]	1.6222 [1.3651]	2.0990 [2.1578]	0.0178 [0.0017]
3. BOND RATINGS							
Constrained Firms	High Hedging Needs (N= 2,329)	0.1552 [0.1482]	0.1275 [0.0896]	0.0320 [0.0334]	1.4176 [1.1117]	2.6238 [2.6813]	0.0097 [–0.0016]
	Low Hedging Needs (N= 1,845)	0.1545 [0.1379]	0.1402 [0.0936]	0.0386 [0.0379]	1.5266 [1.1794]	2.6382 [2.6985]	0.0063 [–0.0030]
Unconstrained Firms	High Hedging Needs (N= 3,048)	0.2214 [0.2043]	0.0844 [0.0520]	0.0227 [0.0265]	1.4035 [1.1677]	2.1455 [2.1976]	0.0138 [0.0000]
	Low Hedging Needs (N= 2,045)	0.1980 [0.1756]	0.1118 [0.0712]	0.0327 [0.0378]	1.7074 [1.3974]	2.1965 [2.2788]	0.0178 [0.0000]
4. COMMERCIAL PAPER RATINGS							
Constrained Firms	High Hedging Needs (N= 3,757)	0.1940 [0.1779]	0.1208 [0.0786]	0.0273 [0.0306]	1.4093 [1.1229]	2.3904 [2.4754]	0.0128 [–0.0013]
	Low Hedging Needs (N= 2,804)	0.1832 [0.1632]	0.1431 [0.0956]	0.0335 [0.0357]	1.5880 [1.2312]	2.4074 [2.5123]	0.0114 [–0.0020]
Unconstrained Firms	High Hedging Needs (N= 1,620)	0.1924 [0.1807]	0.0646 [0.0451]	0.0255 [0.0274]	1.4104 [1.1856]	2.2710 [2.2647]	0.0102 [0.0000]
	Low Hedging Needs (N= 1,086)	0.1664 [0.1529]	0.0824 [0.0539]	0.0405 [0.0418]	1.7086 [1.4496]	2.4086 [2.3794]	0.0148 [0.0000]

Table 3: The Cash Flow Sensitivity of Debt and Cash Holdings

This table displays 3SLS-FE (firm and year effects) results of empirical models for debt issuance and cash holdings (see Eqs. (13) and (14) in the text). Panel A displays the results for long-term debt issuance (net of repurchases), while Panel B displays the results for changes in the holdings of cash and liquid securities. All data are from the annual COMPUSTAT industrial tapes and the sample period is 1971 through 2001. The debt and cash models are jointly estimated (within constraint types) and the empirical error structure allows for unstructured correlation across models. t-statistics (in parentheses).

PANEL A: CASH FLOW SENSITIVITY OF DEBT (NET DEBT ISSUANCE)

Dependent Variable $\Delta Debt_{i,t}$	Independent Variables $CashFlow_{i,t}$	$Q_{i,t}$	$Size_{i,t}$	$\Delta CashHold_{i,t}$	$Debt_{i,t-1}$	R^2	N
FINANCIAL CONSTRAINTS CRITERIA							
1. PAYOUT POLICY							
Constrained Firms	0.0148	–0.0077**	0.0306**	0.0980	–0.2393**	0.11	3,338
	(0.57)	(–3.26)	(9.40)	(1.63)	(–16.49)		
Unconstrained Firms	–0.3531**	0.0004	0.0384**	0.1464**	–0.3301**	0.16	3,835
	(–21.03)	(0.20)	(12.32)	(2.77)	(–21.05)		
2. FIRM SIZE							
Constrained Firms	–0.0037	–0.0072**	0.0365**	–0.0011	–0.2720**	0.11	3,043
	(–0.13)	(–3.16)	(9.40)	(–0.02)	(–17.11)		
Unconstrained Firms	–0.2408**	–0.0031*	0.0240**	0.2829**	–0.2493**	0.10	4,023
	(–11.29)	(–1.93)	(10.41)	(3.24)	(–19.02)		
3. BOND RATINGS							
Constrained Firms	0.0642**	–0.0114**	0.0330**	0.0060	–0.2629**	0.11	3,844
	(2.74)	(–6.50)	(9.40)	(0.14)	(–17.70)		
Unconstrained Firms	–0.2330**	–0.0007	0.0240**	0.1214**	–0.2708**	0.13	7,836
	(–13.50)	(–0.49)	(10.41)	(2.54)	(–28.89)		
4. COMMERCIAL PAPER RATINGS							
Constrained Firms	–0.0633**	–0.0044	0.0344**	0.0359	–0.2636**	0.11	7,039
	(–3.43)	(–2.78)	(15.42)	(0.92)	(–25.94)		
Unconstrained Firms	–0.3183**	–0.0026	0.0262**	0.2113**	–0.2811**	0.14	4,641
	(–14.79)	(–1.61)	(10.93)	(2.91)	(–22.31)		

Notes: *,** indicate statistical significance at the 5- and 1-percent (two-tail) test levels, respectively.

Table 3: — Continued

PANEL B: CASH FLOW SENSITIVITY OF CASH HOLDINGS

Dependent Variable	Independent Variables					R^2	N
$\Delta CashHold_{i,t}$	$CashFlow_{i,t}$	$Q_{i,t}$	$Size_{i,t}$	$\Delta Debt_{i,t}$	$CashHold_{i,t-1}$		
FINANCIAL CONSTRAINTS CRITERIA							
1. PAYOUT POLICY							
Constrained Firms	0.1666**	0.0100**	-0.0085**	0.1826**	–0.3221**	0.12	3,338
	(8.37)	(5.09)	(–2.82)	(3.72)	(–20.05)		
Unconstrained Firms	–0.0088	0.0016	–0.0039	–0.0344	–0.3908**	0.20	3,835
	(–0.54)	(1.35)	(–1.84)	(–1.16)	(–30.78)		
2. FIRM SIZE							
Constrained Firms	0.2201**	0.0064**	–0.0154**	0.1593**	–0.3323**	0.14	3,043
	(9.26)	(2.85)	(–3.69)	(2.84)	(–19.89)		
Unconstrained Firms	0.0026	0.0033**	–0.0042**	0.0326	–0.2385**	0.09	4,023
	(0.19)	(3.53)	(–2.90)	(1.05)	(–19.52)		
3. BOND RATINGS							
Constrained Firms	0.1873**	0.0059**	–0.0072*	0.0770	–0.3439**	0.15	3,844
	(8.56)	(3.20)	(–2.09)	(1.39)	(–23.26)		
Unconstrained Firms	0.0369*	0.0049**	–0.0084**	0.1002**	–0.2951**	0.11	7,836
	(2.21)	(4.89)	(–5.82)	(4.34)	(–31.12)		
4. COMMERCIAL PAPER RATINGS							
Constrained Firms	0.1422**	0.0073**	–0.0091**	0.1422**	–0.3290**	0.13	7,039
	(4.50)	(5.59)	(–4.42)	(4.50)	(–31.27)		
Unconstrained Firms	–0.0061	0.0032*	–0.0069**	–0.0061	–0.2702**	0.10	4,641
	(–0.22)	(3.13)	(–4.25)	(–0.22)	(–22.23)		

Notes: *,** indicate statistical significance at the 5- and 1-percent (two-tail) test levels, respectively.

Table 4: Hedging Needs (Industry-Level R&D Measure) and the Propensity to Save Cash *vs* Pay Down Debt

This table reports 3SLS-FE (firm and year effects) results of empirical models for debt issuance and cash holdings (see Eqs. (13) and (14) in the text). Each cell displays estimates of the coefficient returned for $CashFlow$ (and the associated test statistics) separately for sets of firms with high hedging needs and for sets of firms with low hedging needs. Panel A displays the results returned for financially constrained firms, while Panel B displays the results for financially unconstrained firms. All data are from the annual COMPUSTAT industrial tapes and the sample period is 1971 through 2001. The debt and cash models are jointly estimated (within constraint types) and the empirical error structure allows for unstructured correlation across models. t-statistics (in parentheses).

Panel A: Constrained Firms

	Financial Constraints Criteria			
	Payout Policy	Firm Size	Bond Ratings	CP Ratings
Endogenous Policy Variable:				
1. Debt Issuance (Net of Retirements)				
Firms w/ High Hedging Needs	0.0874*	0.0568	0.1518**	0.0642*
	(2.25)	(1.40)	(3.88)	(2.26)
Firms w/ Low Hedging Needs	–0.1071*	–0.1365*	–0.0812*	–0.2788**
	(–2.03)	(–2.30)	(–2.00)	(–8.42)
P-Value of Diff. High–Low Hedging	[0.00]	[0.01]	[0.00]	[0.00]
2. Increases in Cash Holdings				
Firms w/ High Hedging Needs	0.2011**	0.2571**	0.2532**	0.1852**
	(7.44)	(8.51)	(7.18)	(8.70)
Firms w/ Low Hedging Needs	0.0481	0.0605	0.0987	0.0514
	(0.97)	(0.92)	(1.95)	(1.42)
P-Value of Diff. High–Low Hedging	[0.01]	[0.01]	[0.01]	[0.00]

Notes: *,** indicate statistical significance at the 5- and 1-percent (two-tail) test levels, respectively.

Table 4: — Continued

PANEL B: UNCONSTRAINED FIRMS

	Financial Constraints Criteria			
	Payout Policy	Firm Size	Bond Ratings	CP Ratings
Endogenous Policy Variable:				
1. Debt Issuance (Net of Retirements)				
Firms w/ High Hedging Needs	–0.4277**	–0.1822**	–0.1712**	–0.4650**
	(–9.27)	(–3.50)	(–5.86)	(–10.85)
Firms w/ Low Hedging Needs	–0.5514**	–0.1565**	–0.3680**	–0.2071**
	(–12.75)	(–2.79)	(–9.74)	(–3.14)
P-Value of Diff. High–Low Hedging	[0.05]	[0.74]	[0.00]	[0.00]
2. Increases in Cash Holdings				
Firms w/ High Hedging Needs	0.0356	0.0526	0.1087**	–0.0157
	(1.12)	(1.63)	(5.75)	(–0.47)
Firms w/ Low Hedging Needs	0.0198	–0.0603	–0.0396	–0.0976*
	(0.28)	(–1.63)	(–1.11)	(–2.00)
P-Value of Diff. High–Low Hedging	[0.84]	[0.02]	[0.00]	[0.17]

Notes: *,** indicate statistical significance at the 5- and 1-percent (two-tail) test levels, respectively.

Table 5: Hedging Needs (Industry-Level Sales Growth Measure) and the Propensity to Save Cash *vs* Pay Down Debt

This table reports 3SLS-FE (firm and year effects) results of empirical models for debt issuance and cash holdings (see Eqs. (13) and (14) in the text). Each cell displays estimates of the coefficient returned for $CashFlow$ (and the associated test statistics) separately for sets of firms with high hedging needs and for sets of firms with low hedging needs. Panel A displays the results returned for financially constrained firms, while Panel B displays the results for financially unconstrained firms. All data are from the annual COMPUSTAT industrial tapes and the sample period is 1971 through 2001. The debt and cash models are jointly estimated (within constraint types) and the empirical error structure allows for unstructured correlation across models. t-statistics (in parentheses).

Panel A: Constrained Firms

	Financial Constraints Criteria			
	Payout Policy	Firm Size	Bond Ratings	CP Ratings
Endogenous Policy Variable:				
1. Debt Issuance (Net of Retirements)				
Firms w/ High Hedging Needs	0.1380**	0.1112**	0.1921**	0.1084**
	(3.58)	(2.61)	(5.51)	(3.89)
Firms w/ Low Hedging Needs	–0.1888**	–0.1768**	–0.1125*	–0.3041**
	(–3.79)	(–3.38)	(–2.34)	(–8.66)
P-Value of Diff. High–Low Hedging	[0.00]	[0.00]	[0.00]	[0.00]
2. Increases in Cash Holdings				
Firms w/ High Hedging Needs	0.1997*	0.2662**	0.2180**	0.1924**
	(3.99)	(4.44)	(3.97)	(3.96)
Firms w/ Low Hedging Needs	0.0722	0.0526	0.0185	0.0834
	(1.26)	(0.73)	(0.24)	(1.95)
P-Value of Diff. High–Low Hedging	[0.09]	[0.02]	[0.03]	[0.09]

Notes: *,** indicate statistical significance at the 5- and 1-percent (two-tail) test levels, respectively.

Table 5: — Continued

PANEL B: UNCONSTRAINED FIRMS

	Financial Constraints Criteria			
	Payout Policy	Firm Size	Bond Ratings	CP Ratings
Endogenous Policy Variable:				
1. Debt Issuance (Net of Retirements)				
Firms w/ High Hedging Needs	–0.3537**	–0.2966**	–0.1690**	–0.3996**
	(–9.93)	(–8.87)	(–5.96)	(–11.11)
Firms w/ Low Hedging Needs	–0.5718**	–0.1577*	–0.4109**	–0.3883**
	(–12.85)	(–2.12)	(–11.76)	(–7.23)
P-Value of Diff. High–Low Hedging	[0.00]	[0.10]	[0.00]	[0.86]
2. Increases in Cash Holdings				
Firms w/ High Hedging Needs	–0.0586	0.0436	0.0607	0.0171
	(–1.29)	(1.45)	(1.35)	(0.44)
Firms w/ Low Hedging Needs	0.0042	0.0335	0.0604	–0.0875
	(0.10)	(0.45)	(1.34)	(–0.90)
P-Value of Diff. High–Low Hedging	[0.30]	[0.90]	[1.00]	[0.32]

Notes: *,** indicate statistical significance at the 5- and 1-percent (two-tail) test levels, respectively.

Table 6: Hedging Needs (Industry-Level Q Measure) and the Propensity to Save Cash *vs* Pay Down Debt

This table reports 3SLS-FE (firm and year effects) results of empirical models for debt issuance and cash holdings (see Eqs. (13) and (14) in the text). Each cell displays estimates of the coefficient returned for $CashFlow$ (and the associated test statistics) separately for sets of firms with high hedging needs and for sets of firms with low hedging needs. Panel A displays the results returned for financially constrained firms, while Panel B displays the results for financially unconstrained firms. All data are from the annual COMPUSTAT industrial tapes and the sample period is 1971 through 2001. The debt and cash models are jointly estimated (within constraint types) and the empirical error structure allows for unstructured correlation across models. t-statistics (in parentheses).

Panel A: Constrained Firms

	Financial Constraints Criteria			
	Payout Policy	Firm Size	Bond Ratings	CP Ratings
Endogenous Policy Variable:				
1. Debt Issuance (Net of Retirements)				
Firms w/ High Hedging Needs	0.1685**	0.1401**	0.3237**	0.0983**
	(3.78)	(2.74)	(7.19)	(2.88)
Firms w/ Low Hedging Needs	–0.1206**	–0.1051**	–0.0549*	–0.0348
	(–2.63)	(–2.67)	(–2.03)	(–1.71)
P-Value of Diff. High–Low Hedging	[0.00]	[0.00]	[0.00]	[0.00]
2. Increases in Cash Holdings				
Firms w/ High Hedging Needs	0.1697**	0.2130**	0.1617**	0.1733**
	(5.01)	(4.74)	(4.05)	(6.27)
Firms w/ Low Hedging Needs	0.1400**	0.0727	0.0273	0.0864*
	(2.63)	(1.40)	(0.57)	(2.34)
P-Value of Diff. High–Low Hedging	[0.64]	[0.04]	[0.03]	[0.06]

Notes: *,** indicate statistical significance at the 5- and 1-percent (two-tail) test levels, respectively.

Table 6: — Continued

Panel B: Unconstrained Firms

	Financial Constraints Criteria			
	Payout Policy	Firm Size	Bond Ratings	CP Ratings
Endogenous Policy Variable:				
1. Debt Issuance (Net of Retirements)				
Firms w/ High Hedging Needs	–0.4342**	–0.2890**	–0.2889**	–0.4642**
	(–12.91)	(–8.70)	(–10.56)	(–15.49)
Firms w/ Low Hedging Needs	–0.3406**	–0.1612	–0.2122**	–0.3952**
	(10.47)	(–1.16)	(–3.57)	(–3.26)
P-Value of Diff. High–Low Hedging	[0.05]	[0.37]	[0.24]	[0.58]
2. Increases in Cash Holdings				
Firms w/ High Hedging Needs	0.0097	–0.0174	0.0585*	–0.0332
	(0.25)	(–0.57)	(2.19)	(–1.03)
Firms w/ Low Hedging Needs	–0.1159*	–0.1129*	0.0253	–0.0851
	(–2.20)	(–2.43)	(0.53)	(–1.73)
P-Value of Diff. High–Low Hedging	[0.05]	[0.09]	[0.54]	[0.38]

Notes: *,** indicate statistical significance at the 5- and 1-percent (two-tail) test levels, respectively.