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Financial Constraints, Asset Tangibility, and Corporate Investment*

Heitor Almeida
New York University
halmeida@stern.nyu.edu

Murillo Campello
University of Illinois
campello@uiuc.edu

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Abstract

This paper proposes a new strategy to identify the effect of financial constraints on corporate investment. When firms are able to pledge their assets as collateral, investment and borrowing become endogenous: pledgeable assets support more borrowings that in turn allow for further investments in pledgeable assets. We show that this *credit multiplier* has a first-order effect on investment when firms face financing frictions. In particular, investment–cash flow sensitivities will be *increasing* in the degree of tangibility of constrained firms' assets. When firms are unconstrained, in contrast, investment–cash flow sensitivities are unaffected by asset tangibility. This theoretical prediction allows us to use a "differences in differences" approach to identify the effect of financing frictions on corporate investment: we compare the *differential (marginal) effect* of asset tangibility on the sensitivity of investment to cash flow across *different regimes* of financial constraints. Using two layers of cross-sectional contrasts sidesteps concerns that cash flows might correlate with a firm's (residual) investment opportunities when Q fails as a control. We implement our testing strategy on a large sample of firms drawn from COMPUSTAT between 1971 and 2000. The data strongly support our hypothesis about the role of asset tangibility on corporate investment under financial constraints.

Key words: Investment–cash flow sensitivities, asset tangibility, financial constraints, credit multiplier, macroeconomic shocks.

JEL classification: G31.

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1 Introduction

Whether financing frictions influence real investment decisions is a central, unsettled issue in modern corporate finance (Stein (2001)). A large number of papers in the theoretical literature explore the interplay between financing frictions and investment to study a large array of issues from optimal organizational design (e.g., Gertner et al. (1994) and Stein (1997)) to optimal hedging and cash policies (Froot et al. (1993) and Almeida et al. (2003)). Yet, identifying financing–investment interactions in the real-world is not an obvious task. In a highly influential paper, Fazzari et al. (1988) propose that when firms face financing constraints their investment spending will vary with the availability of internal funds, rather than only with the availability of profitable investment opportunities. Accordingly, one should be able to gauge the effect of financing frictions on corporate investment by comparing the empirical sensitivity of investment to cash flow across samples of financially constrained and unconstrained firms. Examining these sensitivities have since become the standard in the literature that investigates the impact of capital markets imperfections on investment.[1] In recent years, the use of investment–cash flow sensitivities has become widespread in the empirical corporate finance literature. Investment–cash flow sensitivities is one of the key metrics used for drawing inferences about efficiency in internal capital markets (e.g., Lamont (1997) and Shin and Stulz (1998)), the effect of agency on corporate spending (Blanchard et al. (1994) and Hadlock (1998)), the role of business groups in capital allocation (Hoshi et al. (1991)), and the influence of managerial characteristics on corporate policies (Bertrand and Schoar (2001) and Malmendier and Tate (2003)), among others.

A recent string of papers, nonetheless, have pointed to potential problems in the strategy proposed by Fazzari et al. (1988). Kaplan and Zingales (1997) question the usefulness of investment–cash flow sensitivities as a measure of financial constraints, arguing that the Fazzari et al. hypothesis is not a necessary implication of optimal investment under constrained financing. Alti (2003) demonstrates that variations in the informational content of cash flows regarding investment demand can generate the cross-sectional patterns reported by Fazzari et al. even in the absence of financing frictions (see also Gomes (2001)). Erickson and Whited (2000) further show that differences in investment–cash flow sensitivities across constrained and unconstrained firms can be explained by an empirical model in which investment depends only on investment opportunities, where those opportunities are measured with error (see also Cummins et al. (1999)). These various arguments put into question one's ability to draw inferences about the relationship between financ-

[1] A partial list of papers in this literature includes Devereux and Schiantarelli (1990), Whited (1992), Fazzari and Petersen (1993), Himmelberg and Petersen (1994), Bond and Meghir (1995), Calomiris and Hubbard (1995), Gilchrist and Himmelberg (1995), and Kadapakkam et al. (1998). See Hubbard (1998) for a comprehensive survey.

ing frictions and investment by looking at empirical investment–cash flow sensitivities. The current state of the literature is best summarized by Stein (2001, p. 26) in his survey on corporate investment: "While it is becoming very hard to argue with the proposition that financial slack matters for investment, it is much less clear what is the precise mechanism that drives this relationship."

In this paper we develop and test a theoretical argument that allows us to identify whether financing frictions have a direct effect on firm investment behavior. We build on Fazzari et al. (1988) to show that investment–cash flow sensitivities *can* be used as a means of identifying the impact of financing frictions on real investment. The main idea behind our tests is to recognize that variables that increase a firm's ability to contract external finance will have an effect on investment spending when investment demand is constrained by capital market imperfections. One such variable is the *tangibility* of a firm's assets. Assets that are more tangible sustain more external financing because tangibility mitigates underlying contractibility problems — tangibility increases the value that can be readily recaptured by creditors in default states. Through a simple contracting model, we show that investment–cash flow sensitivities will be *increasing* in the tangibility of constrained firms' assets. In contrast, tangibility will have no effect on investment–cash flow sensitivities of unconstrained firms. This theoretical prediction allows us to formulate an empirical test for the link between financial constraints and investment that uses a "differences in differences" approach: we identify the effect of financing frictions on corporate investment by comparing the differential effect of asset tangibility on the sensitivity of investment to cash flow across different regimes of financial constraints.

Why should investment–cash flow sensitivities increase with asset tangibility for some firms but not for others? As we discuss in Section 2, this difference arises from a credit multiplier effect (à la Kiyotaki and Moore (1997)). The intuition is simple. Consider examining the effect of a cash flow shock on investment spending over a cross-section of financially constrained firms — that is, firms that are unable to exhaust their profitable investment opportunities due to financing frictions. Since it is optimal for constrained firms to re-invest their internal funds, the *direct* impact of the income shock on investment is similar for all such firms. However, there is also an *indirect* effect associated with that shock. This latter effect stems from an endogenous change in borrowing capacity. For a given change in investment, the change in borrowing capacity will be greater for those firms whose assets create the highest collateral values — i.e., firms that invest in more pledgeable (tangible) assets. This indirect amplification effect drives the differences in investment–cash flow sensitivities across financially constrained firms in our model. Because the credit multiplier will be greater when assets have higher tangibility, constrained firms that invest in more tangible assets will be more sensitive to cash flow shocks. On the other hand, however, asset tangibility should have no effect on the investment policy of firms that can exhaust their profitable investments opportunities (unconstrained firms).

The upshot of considering a second dimension in which financing frictions manifest themselves is that we can then sidestep the problems associated with previous literature on financial constraints. Because we focus on the *differential effect* of asset tangibility upon investment–cash flow sensitivities *across* constrained and unconstrained firms, it is hard to argue that our results could be generated by a model with no financing frictions where investment opportunities are poorly-measured (Erickson and Whited (2000), Gomes (2001), and Alti (2003)). To wit, while measurement problems might imply a different bias for the *levels* of the estimated investment–cash flow sensitivities across constrained and unconstrained samples, our empirical test is unaffected by those (level) biases in that we focus on the *marginal* effect of tangibility on investment sensitivities exploring an independent mechanism (the credit multiplier). In order to explain our findings with a model with frictionless financing, one would have to explain why the residuals from poorly-measured investment opportunity proxies will load onto variations in asset tangibility across the two firm samples *precisely* along the lines of our predictions. We fail to find such alternative story.

We test our hypotheses on a large sample of manufacturing firms drawn from the COMPUSTAT tapes between 1971 and 2000. In doing so, we estimate investment equations for various subsamples partitioned on the basis of the likelihood that firms have constrained access to capital markets. These empirical equations include an interaction term that captures the effect of tangibility on investment–cash flow sensitivities. We use four alternative approaches suggested by the literature in assigning observations into groups of constrained and unconstrained firms: payout policy, asset size, bond ratings, and commercial paper ratings. Under *each* one of these classification schemes, we find that asset tangibility positively and significantly affects the cash flow sensitivity of investment of financially constrained firms, but that tangibility drives no shifts in those same sensitivities when firms are unconstrained. Importantly, the effect of tangibility on constrained firm investment has sizeable economic significance. For example, while a one-standard-deviation shock to cash flow increases investment spending by 5.1% a year for firms at the first decile of our base measure of tangibility, the same shock increases investment by 12.4% for firms at the ninth decile of that same tangibility measure. Asset tangibility drives no discernible patterns in investment when financially unconstrained firms are hit by a similar income shock. All of these patterns remain after we subject our estimations to a number of robustness checks involving changes to the empirical specification, sample selection criteria, and use of alternative econometric techniques. The results we find are entirely consistent with the implications of our model of the effect of financial constraints and asset tangibility on corporate investment.

As a check of the logic of our results, we then experiment with a "reverse-engineering" approach in which we look at the cash flow sensitivity of investment in activities that arguably entail *no* multiplier effect. This help us identify whether some sort of estimation bias could produce results that go in the same direction of the multiplier effect, even when, in theory, no such effect should exist. To perform this experiment, we develop a testing strategy of the cash flow sensitivity of R&D investment (which presumably has little or no collateral value) that accounts for endogenous fixed investment. We find no evidence that our tangibility measures boost the effect of cash flow shocks on R&D investment.[2]

In the final part of our analysis we pursue the implications of the credit multiplier argument even further, looking at the effect of macroeconomic shocks on the relationship between tangibility and investment–cash flow sensitivities. Theoretically, the availability of credit should vary over time following pro-cyclical movements in the value of collateral. In that case, we should see the effect of tangibility on investment–cash flow sensitivities being magnified during economic booms, when asset (and collateral) values are higher and thus support even greater investment expenditures. In the context of our testing strategy, we should observe a more pronounced impact of tangibility on constrained firms' investment–cash flow sensitivities during booms than in recessions. At the same time, unconstrained firms' investment sensitivities should remain invariant to shocks affecting collateral values. We test this prediction using a two-step procedure relating firm-level and macro-level information that borrows from Almeida et al. (2003) and Campello (2003). We find that macroeconomic innovations lead to shifts on the marginal effect of tangibility on investment–cash flow sensitivities that agree with our credit multiplier hypothesis.

Our study is not the first attempt at designing an empirical test strategy for financial constraints that mitigates the problems in Fazzari et al. (1988). Whited (1992) and Hubbard et al. (1995), for example, use an Euler equation approach that recovers the intertemporal first-order conditions for investment across samples of constrained and unconstrained firms. Blanchard et al. (1994) and Lamont (1997) explore "natural experiments" to bypass the need to control for investment opportunities in standard investment equations. Unfortunately, these studies are not free from criticism. Gilchrist and Himmelberg (1995) argue that the Euler equation approach is unable to identify the presence of constraints when firms are as constrained today as they are in the future, while Stein (2001) questions whether the results from natural experiments should be necessarily interpreted as evidence of financing frictions. In a more recent paper, Almeida et al. (2003) propose

[2]Note that much of the criticism against the Fazzari et al. (1988)-style tests is that they can yield results that are consistent with financing frictions *even* in the absence of any frictions. Our tests, in contrast, fail to return estimates that are suggestive of frictions (through the multiplier) in settings where we do not expect the multiplier mechanism to operate.

replacing investment spending with cash holdings in tests of financial constraints, using cash flow sensitivities of cash as measures of the effect of financial constraints on firm policies. While Almeida et al. interpret their results as evidence of financing frictions, they do not examine investment.

Our paper's findings are related to other strands of the literature. For instance, variations in asset tangibility have been used to explain variations in capital structure (Harris and Raviv (1991) and Rajan and Zingales (1995)), to examine interactions between financial development and industry growth (Claessens and Laeven (2003) and Braun (2003)), and in the valuation of abandonment options by corporate investors (Berger et al. (1996)). Our paper adds to the research on the role of asset tangibility in corporate finance by showing that tangibility has direct, sizeable effects on corporate investment.

The remainder of the paper is organized as follows. In the next section, we lay out a simple model that formalizes our hypothesis about the relationship between investment–cash flow sensitivities, asset tangibility, and financial constraints. In Section 3, we use our proposed empirical strategy to test for financial constraints in a large sample of firms. Section 4 concludes the paper.

2 The Model

In order to introduce the effect of tangibility on investment we study a simple theoretical framework in which firms have limited ability to pledge future cash flows from assets in place and from new investments. We use Hart and Moore's (1994) inalienability of human capital assumption to justify limited pledgeability since this allows us to derive our main implications in a simple, intuitive way. As we discuss in Section 2.2.3, however, our results do not hinge on the inalienability assumption.

2.1 Analysis

The model is structured as follows. There are two dates, 0 and 1. At time 0, the firm has access to a production technology $f(I)$ that generates output (at time 1) from physical investment I. $f(I)$ satisfies standard functional assumptions, but production only occurs if the entrepreneur inputs her human capital. By this we mean that if the entrepreneur abandons the project, only the physical investment I is left in the firm. We assume that some amount of external financing, B, may be needed to initiate the project. Since human capital is inalienable, the entrepreneur cannot credibly commit her input to the production process. It is common knowledge that she may renege on any contract she signs, forcing renegotiation at a future date. As shown in Hart and Moore (1994), the contractual outcome in this framework is such that creditors will only lend up to the expected value of the firm in liquidation.[3] This amount of credit can be sustained by a promised payment equal to the value of physical investment goods under creditors' control, and a covenant establishing a transfer of ownership to creditors in states when the entrepreneur does not make the payment.

Let the physical goods invested by the firm have a price equal to 1, which is constant across time. We model the pledgeability of the firm's assets by assuming that liquidation of those assets by creditors entails firm-specific transaction costs that are proportional to the value of the assets. More precisely, if a firm's physical assets are seized by its creditors at time 1 only a fraction $\tau \in (0,1)$ of the proceeds I can be recovered. τ is a natural function of the tangibility of the firm's physical assets, and of other factors such as the legal environment that dictates the relations between borrowers and creditors.[4] Firms with high τ are able to borrow more because they invest in assets whose value can be largely recaptured by outside investors in liquidation.

Creditors' valuation of assets in liquidation, τI, will establish the borrowing constraint faced by the firm:[5]

$$B \leq \tau I, \tag{1}$$

where B is the amount of new debt that is supported by the project. Notice that this constraint is endogenous in nature: a firm's ability to raise investment funds from outside financiers is conditioned by the tangible value of the new investment.

Besides the new investment opportunity, we assume that the firm also has existing assets that produce cash flows of c_0 at time 0 and c_1 at time 1. Because of limited pledgeability, the firm may be unable to use all of its future cash flows to increase investment today. We define

$$W = c_0 + \lambda c_1 > 0 \tag{2}$$

as the maximum amount of the cash flows from existing assets that the firm can use to invest, where λ captures the degree of pledgeability of future cash flows. For a given firm, λ and τ have similar determinants and thus should be related. For the sake of generality, however, we will treat them as separate parameters. Notice that W depends both on the firm's free cash flows (c_0 and c_1) and on the market imperfections that limit the pledgeability of these cash flows.[6]

The entrepreneur chooses new investment, I, and debt, B, in order to maximize the value of her equity in the firm, e_t, where $t = \{0, 1\}$. Assuming that the discount rate is equal to zero, the

[3] We are assuming for simplicity that the entrepreneur has all the bargaining power in the game that follows her withdrawal from the project.

[4] Myers and Rajan (1998) parametrize the liquidity of a firm's assets in a similar way.

[5] This particular borrowing constraint is discussed in Kiyotaki and Moore (1997).

[6] In a more general model, W would also depend on the firm's existing levels of cash stocks and debt.

entrepreneur solves the program:

$$\max_{I,B}\ (e_0+e_1)\ s.t. \tag{3}$$
$$\begin{aligned} e_0 &= W - I + B \geq 0 \\ e_1 &= f(I) - B \\ B &\leq \tau I. \end{aligned}$$

The firm's optimal investment depends on whether the borrowing constraint is binding. If the borrowing constraint is not binding, then the first-best level of investment will obtain:

$$f'(I^{FB}) = 1. \tag{4}$$

The first-best investment will be feasible so long as

$$W + \tau I^{FB} \geq I^{FB}. \tag{5}$$

Clearly, when internal funds and borrowing capacity are sufficiently high the (unconstrained) efficient level of investment is achieved. On the other hand, investment will be constrained ($I^* < I^{FB}$) when

$$W < W^*(\tau) = (1-\tau)I^{FB}. \tag{6}$$

In this case, the level of investment is directly determined from the firm's budget (or credit) constraint. The model's general expression for the optimal level of investment is

$$\begin{aligned} I(W,\tau) &= \frac{W}{(1-\tau)},\ \text{if } W < W^*(\tau) \\ &= I^{FB},\ \text{if } W \geq W^*(\tau). \end{aligned} \tag{7}$$

And investment–cash flow sensitivities are given by:

$$\begin{aligned} \frac{\partial I}{\partial c_0} &= \frac{\partial I}{\partial W}(W,\tau) = \frac{1}{(1-\tau)},\ \text{if } W < W^*(\tau) \\ &= 0,\ \text{if } W \geq W^*(\tau). \end{aligned} \tag{8}$$

Eq. (8) shows that the investment–cash flow sensitivity *increases* with tangibility when the firm is financially constrained (that is $\frac{\partial^2 I}{\partial c_0 \partial \tau} > 0$, if $W < W^*(\tau)$). The intuition for this result resembles that of the *credit multiplier* of Kiyotaki and Moore (1997), where credit limits are responsible for amplifying and propagating transitory income shocks. In order to see this intuition, consider the effect of a positive cash flow shock that increases W for two constrained firms that have different levels of tangibility. The change in the availability of internal funds, ΔW, has a *direct* effect on constrained investment, which is the same for both firms (equal to ΔW). However, there is also an *indirect* effect that stems from the endogenous change in borrowing capacity (i.e., a relaxation in the credit constraint). This latter effect, which is equal to $\tau\Delta I$, implies that the increase in borrowing capacity will be greater for the high τ firm. In other words, asset tangibility will amplify the effect of exogenous income shocks on the investment spending of financially constrained firms. Eq. (8) also shows that tangibility has no impact on the investment–cash flow sensitivity of an unconstrained firm (a firm for which $W > W^*(\tau)$). We state these results in a proposition:

Proposition 1 *The cash flow sensitivity of investment,* $\frac{\partial I}{\partial c_0}$*, bears the following relationship to asset tangibility:*

i) $\frac{\partial I}{\partial c_0}$ *is increasing in asset tangibility for financially constrained firms*

ii) $\frac{\partial I}{\partial c_0}$ *is independent of asset tangibility for financially unconstrained firms*

2.2 Discussion

Proposition 1 says that the multiplier effect associated with the endogenous change in borrowing capacity following a cash flow shock is higher for those constrained firms whose assets are more tangible. Notice also that the investment–cash flow sensitivity of constrained firms is independent of W. Thus, variables that influence W (such as large cash stocks) should only affect investment sensitivities to the extent that they determine whether the firm will be constrained or unconstrained. The proposition lays out the central idea we want to test in the empirical section. Before we move on to the empirical analysis, however, we discuss a few issues related to our hypothesis.

2.2.1 The role of collateralized debt and inalienability of human capital

In order to derive Proposition 1, we assumed that the external finance capacity generated by the new investment takes the form of collateralized debt. As we discussed, this is directly related to our use of Hart and Moore's (1994) inalienability of human capital assumption. A natural question is: Which aspects of the Hart and Moore framework are strictly necessary for our results to hold?

The crucial element of our theory is that the capacity for external finance generated by new investments is a positive function of the tangibility of the firm's assets (the credit multiplier). The Hart and Moore (1994) setup is a convenient way to generate a relationship between debt capacity and tangibility, but the underlying rationale for why tangibility makes it easier for firms to raise external finance — here, the inalienability of human capital — does not matter. Alternatively, we could have argued that asset tangibility reduces asymmetric information problems because tangible assets' payoffs are easier to measure. Bernanke et al. (1996) explore yet another rationale (agency problems) in their version of the credit multiplier. It should thus be clear that our predictions are not particular to the assumption that human capital is inalienable.

2.2.2 Tangibility and financial status

Proposition 1 states that tangibility should only affect the investment policy of financially constrained firms. But notice that tangibility itself could help determine whether a firm will be constrained in the first place (since W^* is decreasing in τ). Clearly, W^* also depends on factors other than asset tangibility, and we follow previous researchers in exploring variation in these other factors to classify firms into constrained and unconstrained groups. Yet, one might wonder what happens when W^* and τ are very highly correlated. The answer is simple: Proposition 1 holds even under such circumstances. In particular, it is still true that tangibility boosts investment–cash flow sensitivities in a sample of constrained firms. The possibility that the constraint status may also be a function of tangibility implies that, when tangibility is very high, then further increases in tangibility should no longer affect investment sensitivities because the firm becomes unconstrained. This argument suggests that the effect of tangibility on investment–cash flow sensitivities (when they exist) should be driven mostly by firms whose assets have relatively low tangibility. We examine this implication in our empirical tests.

2.2.3 Robustness of the main result

In order to derive Proposition 1, we implicitly assumed that firms cannot raise outside equity or uncollateralized debt — the external finance capacity generated by the new investment takes the form of collateralized-like debt. We also assumed a quantity constraint on external funds — firms can raise external finance up to the value of collateralized debt, and they cannot raise additional external funds irrespective of how much they would be willing to pay. While we make these assumptions for convenience they are *not* strictly required in order for us to isolate the types of investment–cash flow interactions we want to study. Allowing for cost effects, for example, will not change our main implication: there will be a multiplier effect (although potentially weaker) even in a model where firms can raise external finance beyond the limit implied by the quantity constraint.

In order to show the generality of our main result, we modify our model by allowing firms to raise as much uncollateralized finance as they want, so long as they pay the appropriate cost.

Following Froot et al. (1993) and Kaplan and Zingales (1997), we introduce this possibility in our model by assuming that when firms raise finance beyond the limit supported by collateral they pay a (deadweight) cost in addition to the fair cost of raising funds. The cost function $C(\cdot)$ of Froot et al. can be adapted to our framework as

$$C(I - \tau I - W, \tau), \tag{9}$$

where the first term within the parenthesis (denote it by E) is the amount of uncollateralized finance the firm is raising.[7] Note from (9) that we also allow the cost function to depend on tangibility. We also assume that $C(0, \tau) = 0$, $C(E, \tau) > 0$ for $E > 0$, and $C_E > 0$ for all (E, τ). These assumptions mean that there is a "cost premium" $C(E, \tau)$ associated with uncollateralized finance, and that this premium increases with the amount of uncollateralized external finance that the firm is raising.[8] Naturally, if all firms can raise as much uncollateralized finance as they wish without paying a premium they would all become unconstrained. Hence, a positive cost premium is a necessary ingredient for a meaningful theory.

Crucially, notice that collateral (and thus tangibility) still has a role in this model (even when $C_\tau = 0$), because having more collateral reduces the cost of external funds. Else the same, the cost premium $C(I - \tau I - W, \tau)$ is lower when τI (the value of collateral) is higher. Thus, in this model tangibility will still mitigate the effect of financing frictions on investment. We, in turn, show how this effect leads to a multiplier, similarly to the quantity-based model with no uncollateralized finance that we analyzed above.

The first-order condition for investment in this setup is given by:

$$f'(I) = 1 + (1 - \tau) C_E[(1 - \tau)I - W, \tau]. \tag{10}$$

that is, the marginal productivity of investment is equal to the marginal cost of investment, which is the sum of the cost of the investment good plus the marginal cost of external funds. Higher investment requires more external funds, raising the cost premium C.

It is easy to see how tangibility affects the above condition. Suppose that $C_{E\tau} = 0$. Then, if τ is high a given increase in investment (generated, say, by higher cash flows) has a lower effect on the marginal cost of external finance because it generates higher collateralized debt capacity. In other words, tangibility moderates the increase in the cost of external finance following a shock that boosts investment. If τ is low, on the other hand, then the cost of borrowing increases much

[7] Since there is no uncertainty in this model it is difficult to differentiate between outside equity and uncollateralized debt. Essentially, E can be interpreted as the sum of both types of external finance.

[8] Froot et al. (1993) derive a similar cost function using a costly-state-verification framework. In this framework, the "cost premium" arises from monitoring costs or from penalties that must be applied in order to ensure truthful revelation of underlying cash flows.

more rapidly, since the firm has to tap more expensive sources of finance in order to fund the new investment. Because increase in costs dampen the effect of a cash flow shock, investment will respond more to a cash flow shock when the tangibility of the underlying assets is high.[9]

In order to make this point transparent, let us study the effect of tangibility on the sensitivity of investment to cash flow using a simple parameterization of the marginal cost function C_E:

$$C_E[E, \tau] = kE. \tag{11}$$

This assumes that the marginal cost increases linearly with external finance, and that there is no independent effect of tangibility on the marginal cost (i.e., $C_{E\tau} = 0$). One can compute the investment–cash flow sensitivity as

$$\frac{\partial I}{\partial c_0} = \frac{\partial I}{\partial W} = \frac{1}{-f''(I) + (1-\tau)} > 0. \tag{12}$$

It is clear that higher tangibility, τ, increases the investment–cash flow sensitivity because it moderates the increase in the cost of borrowing following a cash flow shock. However, there could also exist a countervailing effect related to the endogeneity of investment. In particular, we have:

$$\frac{\partial I}{\partial W \partial \tau} = \frac{1 + f'''(I)\frac{\partial I}{\partial \tau}}{(-f''(I) + (1-\tau))^2}. \tag{13}$$

If the production function is such that $f'''(I) < 0$, then the investment–cash flow sensitivity may not uniformly increase with τ. Even in this case, though, the multiplier "pushes" the result in the direction of higher sensitivities for more tangible assets.

In sum, the cost-based version of the model generates a multiplier whose effects are similar to the one we describe under quantity constraints. This simple model also shows that the presence of uncollateralized finance does not eliminate the credit multiplier, as long as this alternative source of finance is associated with a cost premium over and above the cost of collateralized borrowing. In the cost-based model, high tangibility moderates the increase in the cost of borrowing following a cash flow shock that increases the amount of investment that is optimal for constrained firms. High tangibility also amplifies the impact of a negative shock, because a decrease in investment will decrease the amount of cheap (collateralized) borrowing that the firm can tap and thus increase the cost of external funds. The only difference is that in the cost version of the model there could be countervailing effects related to changes in the curvature of the production function. These effects might (but will not necessarily) act in the opposite direction of the multiplier. The extent to which countervailing effects could attenuate the multiplier effect is a question that we leave to the data.

[9] Regarding the term $C_{E\tau}$, we believe the most natural assumption would be that the direct effect of tangibility on the marginal costs of external funds is negative, that is, $C_{E\tau} < 0$. This effect would give yet another reason for high tangibility to moderate the increase in the cost of external funds when E increases.

3 Empirical Tests

The main empirical implication of our model is as follows. If a firm is financially constrained and external finance capacity is positively related with the pledgeability of the firm's assets then investment–cash flow sensitivities will increase with asset tangibility. In particular, a positive shock to cash flow will boost investment expenditures for all constrained firms, but the effect of the income shock will be largest for those constrained firms whose assets create the most borrowing capacity. If the firm is unconstrained, on the other hand, investment is largely independent of asset pledgeability, and tangibility will have no systematic impact on investment–cash flow sensitivities.

In order to implement a test of this argument, we need to specify an empirical model relating investment spending with cash flows and asset pledgeability, and also to distinguish between financially constrained and unconstrained firms. We will tackle these two issues shortly, but first let us describe our data.

3.1 Sample

Our sample selection criteria follows Gilchrist and Himmelberg (1995) and Almeida et al. (2003). We consider the universe of manufacturing firms (SICs 2000-3999) over the 1971-2000 period with data available from COMPUSTAT's P/S/T and Research tapes on total assets, market capitalization, capital expenditures, cash holdings, inventories, and plant property and equipment (capital stock). We eliminate firm-years for which the value of capital stock is less than \$5 million (in 1971 dollars), those displaying real asset or sales growth exceeding 100%, and those with negative Q. The first selection rule eliminates very small firms from the sample, for which linear investment models are likely inadequate (see Gilchrist and Himmelberg). The second rule eliminates from the sample those firm-years registering large jumps in business fundamentals (size and sales); these are typicality indicative of mergers, reorganizations, and other major corporate events (see also Almeida et al.). The third data cut-off is introduced as a first attempt to address problems in the measurement of Q from the raw data.[10]

Most studies in the existing literature use relatively short data panels and require firms to provide observations during the entire time period under examination (e.g., Whited (1992), Himmelberg and Petersen (1994), and Gilchrist and Himmelberg (1995)). While there are advantages to this attrition rule in terms of series consistency and stability of the data process, imposing it to our 30-year-long sample would lead to obvious concerns with survivorship biases. We instead

[10]Measurement errors in empirical Q can contaminate inferences about the influence of cash flows on investment (see Erickson and Whited (2000)). We discuss the issue of measurement errors in our estimations in Section 3.2.2.

require that firms only enter our sample if they appear for at least five consecutive years in the data (Bond and Meghir (1994) use a similar approach).[11] Our final sample consists of 32,454 firm-years.

3.2 An Empirical Model of Investment, Cash Flow, and Asset Tangibility

3.2.1 Specification

We experiment with a parsimonious model of investment demand, augmenting the traditional investment equation with a proxy for asset tangibility and an interaction term that allows the effect of cash flows to vary over the range of asset tangibility. Define *Investment* as the ratio of capital expenditures (COMPUSTAT item #128) to beginning-of-period capital stock (lagged item #8). Q is our basic proxy for investment opportunities, 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). *CashFlow* is earnings before extraordinary items and depreciation (item #18 + item #14) divided by the beginning-of-period capital stock.[12] Our empirical model is written as:

$$\begin{aligned} Investment_{i,t} &= \alpha_1 Q_{i,t-1} + \alpha_2 CashFlow_{i,t} + \alpha_3 Tangibility_{i,t} \\ &\quad + \alpha_4 \left(CashFlow \times Tangibility\right)_{i,t} + \sum_i firm_i + \sum_t year_t + \varepsilon_{i,t}, \end{aligned} \tag{14}$$

where *firm* and *year* capture firm- and time-specific effects, respectively.

Asset tangibility (*Tangibility*) is measured in three alternative ways. The first approach we take is to construct a firm-level measure of expected asset liquidation values that borrows from Berger et al. (1996). In determining whether investors rationally value their firms' abandonment option, Berger et al. gather data on proceeds from discontinued operations reported by a sample of COMPUSTAT firms over the 1984-1993 period. The authors find that a dollar's book value produces, on average, 72 cents in exit value for total receivables, 55 cents for inventory, and 54 cents for fixed assets. As in their paper, we estimate liquidation values for the firm-years in our sample via the following computation:

$$Tangibility = 1 \times Cash + 0.715 \times Receivables + 0.547 \times Inventory + 0.535 \times Capital,$$

where *Cash* is COMPUSTAT's item #1, *Receivables* is item #2, and *Inventory* is item #3. As in Berger et al., all of these items are scaled by total book assets; i.e. we divide the liquidation value of the firm's tangibles by the book value of the firm's tangible plus intangible assets.

The second measure of tangibility we use is meant to gauge the specificity of firms' assets. More precisely, the proxy is intended to capture the *ease* with which lenders can liquidate a firm's pro-

[11] Our findings are largely insensitive to the choice of attrition screen.

[12] Results are similar if when use cash flows after dividends (item #18 + item #14 − item #19 − item #21).

ductive capital. Following Kessides (1990) and Worthington (1995), we measure asset redeployment using the ratio of used to used plus new fixed depreciable capital expenditures in the industry. The idea that the degree of activity in asset resale markets (i.e., demand for second-hand capital) will influence financial contractibility along the lines we explore here is proposed by Shleifer and Vishny (1992). To construct this measure, we hand-collect data for used and new capital acquisitions at the four-digit SIC level from the Bureau of Census' *Survey of Manufacturers.* These particular data are compiled by the Bureau once every five years, and the last survey identifying both used and new capital acquisitions was published in 1992. We match our COMPUSTAT dataset with the *Survey of Manufacturers* series using the most timely information on the industry ratio of used to total capital expenditures for every firm-year through our entire sample period.[13] Estimations based on this measure of asset tangibility use smaller sample sizes since not all of COMPUSTAT's SIC codes are present in the Census survey.

The third measure of asset tangibility is similar to the measure just discussed in that we attempt to gauge creditors' ability to readily dispose of a firm's assets in liquidation. Here, too, we use an industry-level indicator of ease of liquidation. Based on the well-documented high cyclicality of durables goods sales, we use industry durable/nondurable dichotomy to associate asset illiquidity to operations in the durables sector. This proxy is also in the spirit of Shleifer and Vishny (1992), who emphasize the decline in collateralized borrowing in circumstances in which assets in receivership will not be assigned to first-best alternative users (other firms in the same industry). Because durables goods producers are systematically cycle-sensitive, negative shocks to demand will typically affect *all* best alternative users of a durable producer's assets, decreasing tangibility. Our third measure of asset tangibility is an indicator variable that assigns firm-years to "more" and "less" tangible industries based on the dichotomy proposed by Sharpe (1994), who groups industries according to the historical covariance between their sales and the GNP. The set of high covariance industries includes all of the durable goods industries (except SICs 32 and 38) plus SIC 30. We refer to these industries as "durables," and to the remaining industries as "nondurables." We expect that assets of firms in nondurables (durables) industries to be perceived as more (less) liquid by lenders, and assign to firms in these industries the value of 1 (0).

We refer to Eq. (14) as our "baseline specification." According to our theory, the extent to which internal funds matter for constrained investment should be an increasing function of asset tangibility. While Eq. (14) is a direct linear measure of the influence of tangibility on investment–cash flow sensitivities, note that its interactive form makes the interpretation of the

[13]For example, we use the 1982 *Survey of Manufacturers* to gauge the asset redeployability of COMPUSTAT firms with 1980 fiscal year as well as for those with 1984 fiscal year. For the post-1992 period we use the information available from the 1992 survey.

estimated coefficients less obvious. In particular, if one wants to assess the partial effect of cash flow on investment, one has to read off the result from $\alpha_2 + \alpha_4 \times Tangibility$.[14] The free variable ($Tangibility$) is usually set at its mean value and the summary statistics reported in Table 2 below will aid the interpretation of our estimates.

3.2.2 Measurement error issues

One issue to consider is whether the presence of Q in our regressions will bias the inferences that we can make about the importance of cash flows for investment decisions. Such concerns have become a major topic of debate in the literature, as evidence of higher investment–cash flow sensitivities for constrained firms has been ascribed to measurement and interpretation problems with regressions including Q (Cummins et al. (1999), Erickson and Whited (2000), Gomes (2001), and Alti (2003)).

These problems are unlikely to affect the inferences that can be made using investment–cash flow sensitivities in the context of our tests. The reason is that our estimations imply simultaneously testing *two* distinct dimensions of the firm's ability to contract external funds in the cross-section: the degree of financial constraints and asset pledgeability. It is hard to argue that measurement problems in Q would systematically carry over the two contrasts and bias our results in the precise direction of our hypothesis. To make this point clear, suppose that Q is a comparatively worse measure of investment opportunities for firms classified as financially constrained — i.e., measurement errors in Q correlate with financial constraints. Then, clearly, since cash flows might correlate with investment opportunities, a higher cash flow coefficient for constrained firms should not be interpreted as evidence for financial constraints. However, notice that our empirical test is completely independent of the *level* of the cash flow coefficients of constrained and unconstrained firms. Our main hypothesis is that tangibility should, on the margin, drive *higher* investment–cash flow sensitivities in the sample of constrained firms (and only in that sample), irrespective of the possibly biased levels of those sensitivities. In order to explain such a finding with a model with frictionless financing, one would have to explain why measurement error in investment opportunities will load onto variations in asset tangibility across the two constraint status *precisely* along the lines of the multiplier effect. In other words, one would need a bias that is systematically stronger for firms with high pledgeability, but *only* if those firms are in the constrained sample.

We fail to find a rationale for why measurement errors in Q would drive our findings. As is standard, nonetheless, in our robustness checks we address concerns with the quality of our

[14] Differently from other papers in the literature, the estimate returned for α_2 alone says little about the impact of cash flow on investment. That coefficient represents the impact of cash flow when tangibility equals zero, a point that is outside of the empirical distribution of our non-categorical measures of tangibility.

empirical measure of future investment opportunities in a number of different ways.

3.3 Financial Constraints Criteria

Testing the implications of our model requires separating firms according to *a priori* measures of the financing frictions they face. Which particular measures to use is a matter of debate in the literature. There are a number of plausible approaches to sorting firms into financially "constrained" and "unconstrained" categories. Since we do not have strong priors about which approach is best, we use a number of alternative schemes to partition our sample. These follow closely the criteria used in Almeida et al. (2003):[15]

- Scheme #1: In every year over the 1971-2000 period we rank firms based on their payout ratio and assign to the financially constrained (unconstrained) group those firms in the bottom (top) three deciles of the annual payout distribution. We compute the payout ratio as the ratio of total distributions (dividends plus stock repurchases) to operating income. The intuition that financially constrained firms have significantly lower payout ratios follows from Fazzari et al. (1988), among others.[16]

- Scheme #2: We rank firms based on their total assets size through the 1971-2000 period and assign to the financially constrained (unconstrained) group those firms in the bottom (top) three deciles of the size distribution. The rankings are again performed on an annual basis. This approach resembles Gilchrist and Himmelberg (1995), who also distinguish between groups of financially constrained and unconstrained firms on the basis of size rankings. The argument for size as 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 those firms that never had their public debt rated during our sample period as financially constrained.[17] Observations from these firms are only assigned to the constrained subsample in years when they report positive debt. Financially unconstrained firms are those whose bonds have been rated during the sample period. Related approaches for characterizing financial constraints are used by

[15] Almeida et al. also use an index measure of the likelihood of financial constraints that is based on Kaplan and Zingales (1997). The authors, however, question the usefulness of the Kaplan-Zingales measure.

[16] The deciles are set according to the distribution of the actual ratio of the payout reported by the firms and thus generate an unequal number of observations assigned to each of our groups. The approach ensures that we do not assign firms with low payouts to the unconstrained group, and that firms with similar payout ratios are always assigned to the same group. Thus, even when more than 30% of the firms have a zero payout in a given year, all zero payout firms are assigned to the constrained group. The minimum payout of the firms in the top three deciles of the payout ranking is 0.42 (across all years); while the maximum payout of the low three decile firms is 0.27.

[17] Comprehensive coverage on bond ratings by COMPUSTAT only starts in the mid-1980s.

Whited (1992), Kashyap et al. (1994), and Gilchrist and Himmelberg (1995). 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 proxy.

- Scheme #4: We retrieve data on firms' commercial paper ratings and assign to the financially constrained group those firms which never had their paper issues rated during our sample period. Observations from these firms are only assigned to the financially constrained subsample when they report positive debt. Firms whose commercial papers are rated at some point during the sample period are considered unconstrained. This approach follows from the work of Calomiris et al. (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 9,819 financially constrained firm-years and 9,745 financially unconstrained firm-years. More interestingly, the table also displays the cross-correlation among the various classification schemes, illustrating the differences in firm sampling across these different criteria. For instance, out of the 9,819 firm-years considered constrained according to payout, 4,441 are also constrained according to size, while 1,531 are considered unconstrained. The remaining firm-years represent payout-constrained firms that are neither constrained nor unconstrained according to the size classification scheme. In general, there is a positive but less than perfect 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.

TABLE 1 ABOUT HERE

Table 2 reports summary statistics for each of our three measures of asset tangibility separately for constrained and unconstrained firm-years. Tangibility seems to vary only to a small degree across constraint types. The first tangibility measure indicates that constrained firms' assets are slightly more liquid than those of unconstrained firms: a constrained firm's assets in liquidation can be expected to receive 55 cents on the dollar, whereas unconstrained firms' assets sell at just over 52 cents. The second tangibility measure also leads to similar inferences about asset tangibility. Our third measure, nonetheless, suggests that constrained firms actually have less tangible assets.

TABLE 2 ABOUT HERE

3.4 Results

Table 3 presents the results obtained from the estimation of our baseline regression model (Eq.(14)) within each of the above sample partitions and for each of our three tangibility proxies. The model is estimated via OLS with firm- and year-fixed effects,[18] and the error structure (estimated via Huber-White) allows for residual heteroskedasticity and time clustering. A total of 8 estimated equations (4 constraints criteria $\times$ 2 constraints categories) are reported in each of the 3 panels in the table, yielding 12 constrained–unconstrained comparison pairs.

TABLE 3 ABOUT HERE

Each and every one of the 12 regression pairs in Table 3 gives the same result: constrained firms' investment–cash flow sensitivities are increasing in asset tangibility, while unconstrained firms' sensitivities show no or little response (often in the opposite direction) to tangibility. The interaction between cash flow and tangibility attracts positive, statistically significant coefficients in virtually all of the constrained firm estimations. These coefficients are uniformly higher than those of the unconstrained samples, and different at the 1% test level in 10 of the 12 pairs. The results we find are fully consistent with the presence of a credit multiplier effect for constrained firm investment that works along the lines of our model.

To illustrate the effect of tangibility on the sensitivity of investment to cash flows we consider the most conservative estimates in Panel A of Table 3 (the payout sample split). Those coefficients suggest that the effect of a one-standard-deviation shock to a constrained firm's cash flow (equal to 1.002) increases investment rates by 9.2% at the mean of the distribution of *Tangibility* ($= (-0.103 + 0.358 \times 0.545) \times 1.002$); an effect that is significant at the 1% level. To fully appreciate the economic impact of asset tangibility on investment sensitivities one should further allow for variations in tangibility. Accordingly, note that when calculated at the first decile of *Tangibility* (i.e., at 0.429) the partial effect of the cash flow shock on investment is about 5.1%, while at the ninth decile of the same measure (0.670) that partial effect equals 12.4% (t-stat of 8.25). Analogous calculations for unconstrained firms yield mostly economically and statistically insignificant effects.

3.5 Robustness Tests

We subject our empirical findings to a number of robustness checks in order to address potential concerns about model specification and other estimation issues. We report the results from these

[18] The only exception applies to the results in the last panel (durables/nondurables dichotomy), where including firm-fixed effects is unfeasible since firms are assigned to only one industry category over time.

checks in Table 4. To save space, we present only the coefficient estimates returned for the interaction term $CashFlow \times Tangibility$ since, as in the previous tables, their magnitudes largely dominate those of the estimates returned for the original intercept regressors. For ease of exposition, we only discuss the results associated with our first proxy for asset tangibility.[19]

TABLE 4 ABOUT HERE

The first column of Table 4 details the changes we impose to our baseline model at each round of estimations. In the estimations reported in the first row of the table, we add one lag of log sales growth to the baseline model. The strategy of adding this type of additional control has been commonly employed in the earlier studies (e.g., Fazzari et al. (1988), Himmelberg and Petersen (1994), and Kadapakkam et al. (1998)) as a way to ameliorate concerns with the quality of Q as a proxy for investment opportunities. Adding sales growth leads to negligible changes to our original estimates. The same occurs when we add two lags of Q (see row 2) and extra lags of cash flow (unreported). In the third row of Table 4, we use lagged Q and sales growth as instruments for Q (as opposed to added controls). We estimate this equation via GMM. Following Bound et al. (1995), instrument *relevance* is confirmed by looking at the excluded instruments' squared partial correlation.[20] Instrument *validity* is checked via Hansen's (1982) J-statistic.[21] Results in row 3 reveal very little changes to the interaction effects between cash flow and tangibility in our investment equation.

In the fourth row, we adopt a more novel approach to the concern that Q is poorly measured. Following Cummins et al. (1999) and Abel and Eberly (2001), we use financial analysts' forecasts of earnings as an instrument for Q in a GMM estimation of our baseline model. As in Polk and Sapienza (2002) and Almeida et al. (2003), we employ the median forecast of the one year-ahead earnings scaled by lagged total assets to construct the earnings forecast measure. The earnings data come from I/B/E/S, where extensive data coverage only starts in 1982. Although, only some 53% of the firm-years in our original sample provide valid observations for earnings forecast, our basic results remain nearly intact.

In row 5, we experiment with the lagging structure of some previous papers in the literature (e.g., Calomiris and Hubbard (1995)), and lag not only Q, but also *CashFlow*, doing similarly for

[19] The full set of regression estimates, including those from the other two measures of tangibility, are available from the authors.

[20] The first-stage regression for payout constrained (unconstrained) firms, for example, produces a R^2 of 42% (54%) and the associated F-test for the excluded instrument regressors is 2,242.3 (4,822.7). The first-stage regressions from the other sample partitions yield similar statistics.

[21] For each one of these estimations we can safely accept the null that the instrument set satisfies the orthogonality conditions. The lowest p-value we obtain for the J-statistic across all eight estimations is 62%.

Tangibility and the interaction term. While this yields some noticeable changes in the coefficient estimates, our conclusions continue to hold for all but one of the sample splits (bond ratings).

In row 6, we consider the possibility that our inferences about the effect of cash flow on investment could be compromised by our failure to account for firms' ability to smooth the impact of cash flow shocks with use of alternative, readily available sources of internal funds. This possibility is explored in Fazzari and Petersen (1993), who show that manufacturing firms reduce adjustment costs and losses due to the perishability of projects by choosing to absorb negative shocks to cash flow with disproportionately larger cuts in working capital investment than in fixed investment. We include a proxy for *changes* in net working capital[22] to our specification and, following Fazzari and Petersen, instrument this added choice variable with the beginning-of-period *stock* of working capital.[23] This new round of estimations yields results that are similar to those of our base model.

In row 7, we experiment with the Euler-type investment demand model proposed by Bond and Meghir (1994), adding the lag of investment, its square, the lagged ratio of sales to capital, and the square, lagged debt-to-capital ratio to the set of regressors. In estimating this lagged dependent variable model, we use the two-step dynamic panel GMM estimator proposed by Arellano and Bond (1991), where differenced regressors are instrumented by their lagged levels.[24] Our conclusions about the multiplier effect on the constrained sample investment continue to hold even though the Arellano-Bond estimates are somewhat smaller.

Finally, because of concerns with the possibility of extreme outliers having undue influence on our results, we estimate our models via quantile regression. Row 8 of Table 4 indicates that our inferences cannot be ascribed to the effects of outlying observations.

3.6 Tangibility and Constraint Status

As we discussed in Section 2.2.2, besides governing the credit multiplier, the tangibility of a firm's assets could potentially help determine whether or not a firm is financially constrained. The possibility that the constraint status may also be a function of tangibility implies that when tangibility is very high further increases in tangibility should no longer affect investment sensitivities. In this section, we examine this possibility by using variations in asset tangibility as an alternative way to split our data into constrained and unconstrained subsamples.

We use our first proxy for asset tangibility (based on Berger et al. (1996)), and, on an annual

[22] Net working capital is computed as (item#1 + item #2 + item #3 − item #70)/(item #6).

[23] The rationale for this instrument is that investment in an specific asset category should depend negatively on the initial stock of that asset because of decreasing marginal valuation associated with stock levels.

[24] The smallest p-value we obtain for the Sargan test of instrument set validity (rejection of the null of orthogonality conditions being held) is 9%. Our Sargan-test statistics are generally comparable to those in Bond and Meghir.

basis over the 1971-2000 period, assign to the financially constrained (unconstrained) group those firms in the bottom (top) three deciles of the tangibility distribution. We then test whether the marginal effect of tangibility on investment–cash flow sensitivities is larger in the low tangibility (constrained) subsample by fitting Eq. (14) separately to each group. Our results suggest that the effect of tangibility on cash flow sensitivities is indeed stronger for firms with low asset tangibility. We find the following coefficients for the low-tangibility subsample:

$$Investment = \underset{(7.40)}{0.058}Q - \underset{(-4.88)}{0.128}CashFlow - \underset{(-1.79)}{0.071}Tangibility + \underset{(5.36)}{0.450}(CashFlow \times Tangibility),$$

where the coefficient on the interaction term is significant at the 1% level (t-stat of 5.36). In contrast, we obtain the following estimates for the high-tangibility sample:

$$Investment = \underset{(6.13)}{0.032}Q + \underset{(1.43)}{0.098}CashFlow - \underset{(-5.49)}{0.297}Tangibility + \underset{(0.68)}{0.064}(CashFlow \times Tangibility),$$

where the coefficient on the interaction term is statistically insignificant.

These results are consistent with our basic hypothesis that tangibility boosts investment–cash flow sensitivities for constrained firms, and they also suggest that the effect of asset tangibility on investment–cash flow sensitivities is to some extent non-linear. At very high levels, tangibility ceases to have a significant effect on investment–cash flow sensitivities.

3.7 Different Types of Investment: Fixed Capital versus R&D Expenditures

A direct implication of the credit multiplier hypothesis is that the endogenous change in debt capacity should vary across the *types* of investments made by a firm. For example, differently from capital expenditures, investments in intangible assets do not generate additional debt capacity, and thus should not yield a multiplier effect. This observation is useful in checking whether our inferences are warranted. Looking at different types of investment expenditures for the same firm will allow us to verify whether the effect of tangibility varies across these investments along the lines of our credit multiplier story.

Unfortunately, COMPUSTAT's capital expenditures data do not allow us to disaggregate investment into components that differ according to their level of tangibility. On the other hand, COMPUSTAT has data on one type of investment whose tangibility level is arguably low: R&D investment. Given that R&D investments have little or no tangible attributes, increases in R&D *per se* should have little or no effect on the firm's debt capacity. Notice, though, that because a cash flow innovation will translate into variations in both R&D and fixed capital expenditures for a constrained firm (see Himmelberg and Petersen (1994)), it is possible that the amplification effect that stems from regular capital expenditures will correlate with R&D investments. Thus, it is not necessarily the case that the cash flow sensitivity of R&D investment is uncorrelated with tangibility in the data, even when R&D adds nothing to a firm's debt capacity. In this section, we explore a way to sidestep this difficulty and show additional evidence that a credit multiplier effect — which is absent from investment in intangibles — drives our main findings.

To motivate an empirical model that allows us to differentiate the effect of asset pledgeability on a firm's investments in tangible versus intangible assets, we modify the model of Section 2 by introducing R&D investment. We model R&D expenditures as an alternative use for the company's funds and assume that R&D adds nothing to the company's debt capacity. Assume that a firm's investment in R&D, $I_{R\&D}$, produces a future cash flow that is equal to $g(I_{R\&D})$; where the function $g(\cdot)$ satisfies standard functional assumptions. The firm chooses how much to invest in capital and R&D by solving the following problem:

$$\max\left[f(I) - I + g(I_{R\&D}) - I_{R\&D}\right] \; s.t. \tag{15}$$

$$\begin{aligned} I + I_{R\&D} &\leq W + B \\ B &\leq \tau I \end{aligned}$$

Note that the only difference between $I_{R\&D}$ and I is that $I_{R\&D}$ does not create any additional capacity for external finance. The first-best levels of investment are given by:

$$f'(I^{FB}) = g'(I^{FB}_{R\&D}) = 1. \tag{16}$$

As in Section 2, the firm invests at the first-best level if there is a feasible debt level B that satisfies both constraints in program (15) for $I = I^{FB}$ and $I_{R\&D} = I^{FB}_{R\&D}$. Otherwise, the firm will be financially constrained and will solve the following problem:

$$\max\left[f(I) - I + g(I_{R\&D}) - I_{R\&D}\right] \; s.t. \tag{17}$$

$$W = (1-\tau)I + I_{R\&D}$$

The solution to this problem are investment levels I^* and $I_{R\&D}$ that satisfy:[25]

$$\begin{aligned} f'(I^*) &= (1-\tau)g'(I^*_{R\&D}) + \tau \\ W &= (1-\tau)I^* + I^*_{R\&D}. \end{aligned} \tag{18}$$

This system of equations determines I^* and $I^*_{R\&D}$. Notice that the first equation implies that $f'(I^*) < g'(I^*_{R\&D})$. The constrained firm will invest relatively more in fixed capital than in R&D

[25] We are assuming an interior solution where both investments are positive. We can also show that both investments are below the first-best levels when the firm is constrained.

because hard assets add to the firm's debt capacity, relaxing constraints. In order to facilitate the empirical implementation of this model we assume that the marginal productivity functions are linear:[26]

$$f'(I) = a - bI \qquad \text{and} \qquad g'(I_{R\&D}) = c - dI_{R\&D}. \tag{19}$$

We can then write the solution of the model as a system of equations for I, $I_{R\&D}$, and W:

$$\begin{aligned} \alpha I^* - \beta_\tau I^*_{R\&D} &= \delta_\tau \\ (1-\tau)I^* + I^*_{R\&D} &= W, \end{aligned} \tag{20}$$

where the parameters α, β_τ, and δ_τ can be solved out as functions of the production function parameters and of τ. The subscripts underscore the fact that β and δ depend on τ. Both α and β_τ are positive parameters.[27]

This model delivers a direct way of empirically identifying the absence of a multiplier coming from R&D investment. Notice first that the optimal amount of R&D investment can be solved as:

$$I^*_{R\&D} = \frac{1}{1 + \frac{(1-\tau)\beta_\tau}{\alpha}} W - \frac{(1-\tau)\delta_\tau}{\alpha - (1-\tau)\beta_\tau}. \tag{21}$$

And the cash flow sensitivity of R&D investment is:

$$\frac{\partial I^*_{R\&D}}{\partial W} = \frac{1}{1 + \frac{(1-\tau)\beta_\tau}{\alpha}} = \frac{1}{1 + \frac{(1-\tau)^2 d}{b}} > 0. \tag{22}$$

Even though R&D does not add to the firm's debt capacity, the cash flow sensitivity of R&D investment is *increasing* in the tangibility of the firm's assets. This effect is transmitted through (endogenous) capital expenditures as follows. A positive cash flow shock will increase capital expenditures, which in turn will increase the firm's debt capacity. Because this increase is greater when tangibility is higher, a firm with high tangibility will be able to increase R&D by a greater amount than a firm with low tangibility assets. And thus we get a R&D–cash flow sensitivity that is increasing in tangibility even when R&D itself does not add to the firm's debt capacity.

So how can we verify the absence of a multiplier in R&D expenditures? Our simple model suggests a feasible strategy. We *should not* estimate a reduced form equation such as Eq. (21). Instead, the equation that we want to estimate is the structural equation that links the firm's sources and uses of funds:

$$(1-\tau)I^* + I^*_{R\&D} = W, \tag{23}$$

[26] We also make the customary assumptions needed to avoid negative marginal productivities. In addition, parameters a, b, c, d are assumed positive.

[27] In fact, $\alpha = b$ and $\beta_\tau = (1-\tau)d$.

or,

$$I^*_{R\&D} = W - (1-\tau)I^*. \quad (24)$$

Controlling for the level of endogenous fixed capital investment, I^*, the cash flow sensitivity of $I^*_{R\&D}$ is equal to one, and is thus independent of tangibility. That is, if we can empirically estimate the derivative $\frac{\partial I_{R\&D}}{\partial W}\|_{I=I^*}$, we can test the implication that this derivative should be independent of the tangibility of the firm's assets. One way to perform this estimation is to use a two-stage least squares procedure, whereby we estimate the firm's expected capital investment in the first stage as a function of all the exogenous parameters, and then include the predicted values from this equation in a second-stage equation where we relate R&D investment to cash flows and endogenous investment (Eq. (24)).

This proposed strategy can be readily implemented within our framework by fitting our baseline investment equation (Eq. (14)) to the data in order to generate predicted investment values (denoted by $\widehat{I}$) and then running a regression of $I_{R\&D}$ on $\widehat{I}$:

$$\begin{aligned} I_{R\&Di,t} &= \beta_1 \widehat{I}_{i,t} + \beta_2 CashFlow_{i,t} + \beta_3 Tangibility_{i,t} \\ &+ \beta_4 \left(CashFlow \times Tangibility\right)_{i,t} + \sum_i firm_i + \sum_t year_t + \varepsilon_{i,t.} \end{aligned} \quad (25)$$

Importantly, note that we are interested in estimating Eq. (24) and thus do not need to include proxies for investment opportunities in the set of regressors in Eq. (25). This allows us to use lagged Q to identify the model.[28] Our hypothesis is that the effect of cash flow on *R&D* investment is independent of tangibility, even for constrained firms.

Table 5 reports the results from the estimation of Eq. (25). To help illustrate the adequacy of our IV approach, the table also displays the first-stage regressions R^2's (fifth column). These are very similar to those observed in the baseline estimations of Table 3. Focusing on the estimates of interest, note that while there is indeed a strong association between R&D and fixed capital expenditures, once this association is controlled for, it is *not* the case that the sensitivity of R&D expenditures to cash flow will be increasing in the level of asset tangibility. In fact, *all* of the $CashFlow \times Tangibility$ interaction terms attract *negative* (mostly statistically insignificant) coefficients. These results help verify that it is not the case that a spurious bias in our tests leads to results that seem to agree with the multiplier effect even in the absence of the multiplier.

<u>TABLE 5 ABOUT HERE</u>

[28] We let Q provide the extra vector dimensionality necessary for model identification because this follows more naturally from the empirical framework we use in the paper. In unreported estimations, however, we experiment with alternative regressors (e.g., sales growth) and obtain the same results.

3.8 Macroeconomic Dynamics: Intertemporal Shocks to Collateral Values

We claim that tangibility boosts the impact of cash flow on capital expenditures because of a credit multiplier effect. Accordingly, firms with high tangibility display higher investment–cash flow sensitivities. Whereas we have documented this relationship to hold "on average" for the duration of our sample period, a natural way to investigate the robustness of the mechanism we describe is to look at the intertemporal dynamics of the credit multiplier.

According to the theory (Bernanke et al. (1996) and Kiyotaki and Moore (1997)), the availability of credit for investment should vary over time following pro-cyclical movements in the value of collateral. During economic booms, the prices of the assets in which firms invest (and thus their collateral values) will increase. Because constrained investment increases with collateral, a given set of assets will support greater capacity for external finance and investment expenditures during booms — i.e., firms with more tangible (say, fixed) assets in their balance sheets borrow and invest more.[29] This contrasts sharply with what happens during recessions, when collateral values are sharply depressed and asset tangibility *per se* drives little or no (cross-sectional) differences in firms' ability to borrow and invest.[30] If these conjectures are correct, we should expect the effect that our empirical tangibility measures exert over investment–cash flow sensitivities to vary over the business cycle. In particular, we should expect those measures to exert a larger boosting effect on investment–cash flow sensitivities of financially constrained firms during booms (when collateral values are high) than in recessions (when collateral values are depressed). Unconstrained firms' investment sensitivities, on the other hand, should remain invariant to shocks affecting collateral values.[31]

3.8.1 Firm responses to macroeconomic movements: A two-step testing strategy

We test our argument about the intertemporal dynamics of the multiplier effect via a two-step approach that is similar to that used by Almeida et al. (2003) and Campello (2003). The idea is to relate the sensitivity of investment to cash flow and shocks to economic activity by combining cross-sectional and times series regressions. The approach sacrifices statistical efficiency, but reduces

[29] An increase in asset prices will also have a countervailing negative effect on investment due to the negative slope of the demand for investment. However, as argued by Stein (1995) and Kiyotaki and Moore (1997), if the ability to borrow is directly tied to asset values, higher asset prices will lead to *higher* asset demand by constrained agents, because higher prices relax their liquidity constraints.

[30] When we say that asset *tangibility* is a less valuable attribute during recessions, we mean that although a firm might have a large proportion of tangible assets in its balance sheet, the true liquidation value of those assets may be severely compromised, providing little or no collateral to lenders.

[31] If enough agents become unconstrained during booms the effect of collateral on investment-cash flow sensitivities might decrease. Clearly, it is not obvious that less agents are constrained during booms since the set of profitable investment opportunities also expands.

the likelihood of Type I inference errors; that is, it reduces the odds of concluding that investment expenditures respond to cash flow innovations along the lines of our theory when they really don't.[32]

The first step of our procedure consists of estimating the baseline regression model (Eq. (14)) every year, separately for groups of financially constrained and unconstrained firms. From each sequence of cross-sectional regressions, we collect the coefficients returned for the interaction between cash flow and tangibility (i.e., α_4) and 'stack' them into the vector Ψ_t, which is then used as the dependent variable in the following (second-stage) time series regression:[33]

$$\Psi_t = \eta + \sum_{k=1}^{3} \phi_k \Delta Log(GDP)_{t-k} + \beta \Delta Log(CPI)_t + \lambda \Delta FF_t + \rho Trend_t + u_t. \tag{26}$$

We are interested in the impact of aggregate activity shocks, proxied by the change in real log GDP, on the importance of tangibility in affecting investment–cash flow sensitivities. The economic and the statistical significance of aggregate activity shocks can be gauged from the sum of the coefficients for the lags of GDP, $\sum \phi_k$, and from the t-statistics of this sum. We also report p-values for the rejection of the hypothesis that the lags of GDP do not help forecast the impact of tangibility on sensitivities. We allow for a few lags of GDP to account for the fact that macroeconomic movements spread out at different speeds throughout different sectors of the economy and that fixed investment is particularly slow to respond.[34] Because movements in aggregate demand and other key macroeconomic variables tend to coincide, we also include controls for changes in inflation (log CPI) and basic interest rates (Fed funds rate, or FF) to ensure that our findings are not driven by other contemporaneous macroeconomic innovations affecting investment.[35] Finally, a time trend ($Trend$) is included to capture secular changes in the dependent variable.

3.8.2 Cross-sectional comparisons

To the extent that investment demand should be affected by aggregate activity, the movements we observe in investment–cash flow sensitivities could be driven by the correlation between investment and activity *only*. This could pose a problem to our identification strategy. Fortunately, our theory

[32] An alternative one-step specification — with Eq. (26) below nested in Eq. (14) — would impose a more constrained parametrization and have more power to reject the null hypothesis that macro shocks have no impact on the relation between tangibility and investment-cash flow sensitivities.

[33] To see how this procedure accounts for the error contained in the first step, assume that the true Ψ_t^* equals what is estimated from the first-step run (Ψ_t) plus some residual (ν_t): $\Psi_t^* = \Psi_t + \nu_t$. One would like to estimate Eq. (26) as $\Psi_t^* = \alpha + \mathbf{X}\boldsymbol{\theta} + \omega_t$, where the error term would only reflect the errors associated with model misspecification. However, the empirical version of Eq. (26) uses Ψ_t (rather than Ψ_t^*) on the right hand-side. Consequently, so long as $E[\mathbf{X}'\nu] = 0$, η will absorb the mean of ν_t, while u_t will be a mixture of ν_t and ω_t. Thus, the measurement errors of the first step will increase the total error variance in the second step, but will not bias the coefficient estimates in $\boldsymbol{\theta}$.

[34] Not allowing for lagged responses could bias our results if the distribution of financially constrained firms happen to be more concentrated in sectors of the economy that respond more rapidly to changes in demand.

[35] We gather these series from the Bureau of Labor Statistics and the Federal Reserve (*Statistical Release H.15*).

(and previous evidence) provides for a solution: since tangibility plays no determinant role in the investment of unconstrained firms, we can use these firms' responses to macroeconomic conditions as a way to extract the "correlation bias" between investment and macro activity. Under this approach, our conclusions should be based on comparisons between constrained and unconstrained firms' responses to macro shocks. The tests below will thus emphasize *cross-sectional differences* in the response of the interplay between internal funds and tangibility to macroeconomic shocks across constrained and unconstrained firms.[36]

3.8.3 Results

The results from the two-stage estimator are summarized in Table 6. The table reports the coefficients for $\sum \phi$ from Eq. (26) along with the associated p-values (calculated via Newey-West). Row 1 collects the results for financially constrained firms and row 2 reports results for unconstrained firms. Additional tests for differences between coefficients across groups are reported in the bottom of the table (row 3). Standard errors for the "difference coefficients" (across equations) are estimated via a SUR system that combines the two constraint categories (p-values reported).

TABLE 6 ABOUT HERE

The GDP-response coefficients for the constrained firms displayed in row 1 are positive and generally statistically significant, suggesting that asset tangibility has a higher (more positive) impact on constrained firms' investment–cash flow sensitivities during booms, as we have conjectured. Those same GDP coefficients are all negative when the two-stage regressions are estimated over our various unconstrained firm partitions. The exclusion test p-values show that economic activity is relevant in predicting the effect of tangibility on cash flow–investment interactions beyond what changes in inflation and interest rates alone would predict. Changes in GDP have marginal predictive power at a significance level better than 5% in all but two cases. Finally, note that all of the difference coefficients have the expected positive sign, although high statistical significance is not always achieved. We interpret these macro-level results as consistent with the role of asset tangibility in amplifying the effect of cash flow innovations on investment under credit constraints. In other words, these tests provide additional support to the argument that a credit multiplier influences the sensitivity of corporate investment to cash flows.

[36] Kashyap and Stein (2000) and Campello (2003) prescribe the very same technique of using a benchmark group as a control for the correlation between the dependent variable in the first-step regression and macroeconomic movements in their second-step times-series regressions.

4 Concluding Remarks

One of the most important research topics in financial economics is the question of whether financing frictions affect real investments. Under frictionless financing, one should expect investment demand to depend only on the availability of profitable investment opportunities. Arguably, however, financing frictions could create a channel through which financial variables such as cash and cash flow affect corporate investment. Despite the plausibility of such a channel, previous literature has found it hard to design an empirical test showing that financing frictions have direct, unambiguous effects on corporate investment (see Stein (2001)).

Our study attempts to provide new evidence that financing frictions indeed significantly affect investment decisions. Our starting point is the idea that asset pledgeability should have a direct effect on corporate investment when investment demand is constrained by financing frictions. We argue that, because of a credit multiplier effect, investment–cash flow sensitivities will be increasing with the tangibility of firms' assets for constrained firms, but unrelated to tangibility in a sample of unconstrained firms. This prediction allows us to identify the effect of financing frictions on investment using a "differences in differences" approach: we compare the *differential effect* of asset tangibility on the sensitivity of investment to cash flow *across* constrained and unconstrained firms. Because our testing strategy does not rely on the absolute *levels* of investment–cash flow sensitivities in constrained and unconstrained samples, it is less subject to the problems that are associated with the traditional Fazzari et al.'s (1988) approach.

The evidence we uncover in this paper is consistent with the presence of a channel in which the causation goes from financing frictions to investment. As hypothesized, asset tangibility matters only within samples of firms that are *a priori* classified as more likely to be financially constrained. Furthermore, it matters precisely in the way suggested by our theory: tangibility increases investment–cash flow sensitivities for financially constrained firms. Our results are very robust. They hold for all of the different combinations between empirical proxies for financial constraints and tangibility that we are able to gather, all of which come from the previous literature. Our conclusions continue to hold after we subject our estimations to a number of robustness checks involving changes in empirical specifications and econometric methods. We also demonstrate in the data that the cash flow sensitivity of investment activities that entail no credit multiplier effects (R&D) is indeed unaffected by tangibility. This suggests that our tests indeed differentiate between settings where the multiplier mechanism should work from those where it should not. Finally, and also consistent with the premises of a credit multiplier as the driver of the effects we uncover, we find that the effect of tangibility on constrained investment–cash flow sensitivities is magnified during economic booms. Overall, our evidence suggests that asset tangibility has an important role in boosting the impact of income shocks on corporate investment.

While we use asset liquidity/specificity to identify the effect of financing frictions on investment, we emphasize that this is not the only way of implementing our empirical testing strategy. The basic insight behind our tests is that variables that change debt capacity have a particularly strong effect on the investment policy of firms that face financing frictions. In principle, one could design similar tests using other variables that change a firm's debt capacity. Of course, not all of those variables might give rise to a credit multiplier, and thus the particular form of these alternative tests might be different than ours. We think these alternative testing strategies are interesting topics for future research on investment and other corporate policies under financial constraints.

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Table 1: Cross-Classification of Financial Constraint Types

This table displays firm-year cross-classification for the various criteria used to categorize firm-years as either financially constrained or unconstrained (see text for definitions). The sampled firms include only manufacturers (SICs 2000-3999) in the COMPUSTAT annual industrial tapes. The sample period is 1971 through 2000.

Financial Constraints Criteria	Payout Policy		Firm Size		Bond Ratings		CP Ratings	
	(A)	(B)	(A)	(B)	(A)	(B)	(A)	(B)
1. Payout Policy								
Constrained Firms (A)	9,819							
Unconstrained Firms (B)		9,745						
2. Firm Size								
Constrained Firms (A)	4,441	1,973	9,747					
Unconstrained Firms (B)	1,531	4,175		10,046				
3. Bond Ratings								
Constrained Firms (A)	6,657	5,183	8,655	2,740	19,504			
Unconstrained Firms (B)	3,162	4,562	1,092	7,306		12,950		
4. Commercial Paper Ratings								
Constrained Firms (A)	8,958	6,593	9,659	4,403	19,146	6,204	25,350	
Unconstrained Firms (B)	861	3,152	88	5,643	358	6,746		7,104

Table 2: Summary Statistics of Asset Tangibility across Constraint Types

This table displays summary statistics for asset tangibility across groups of financially constrained and unconstrained firms (see text for definitions). The sampled firms include only manufacturers (SICs 2000-3999) and the sample period is 1971 through 2000.

Tangibility Measures	Firm-level asset liquidation values			Industry-level asset redeployment ratio			Nondurables industries Sharpe's (1994) indicator		
	Mean	Median	N	Mean	Median	N	Mean	Median	N
FINANCIAL CONSTRAINTS CRITERIA									
1. PAYOUT POLICY									
Constrained Firms	0.545	0.557	9,819	0.071	0.058	8,144	0.411	0	9,819
Unconstrained Firms	0.534	0.547	9,745	0.068	0.053	7,275	0.538	1	9,745
2. FIRM SIZE									
Constrained Firms	0.566	0.571	9,747	0.078	0.066	7,333	0.428	0	9,747
Unconstrained Firms	0.515	0.534	10,046	0.062	0.046	7,547	0.553	1	10,046
3. BOND RATINGS									
Constrained Firms	0.559	0.567	19,504	0.072	0.059	15,929	0.469	0	19,504
Unconstrained Firms	0.519	0.536	12,950	0.067	0.051	8,467	0.506	1	12,950
4. COMMERCIAL PAPER RATINGS									
Constrained Firms	0.551	0.562	25,350	0.072	0.059	20,127	0.456	0	25,350
Unconstrained Firms	0.516	0.532	7,104	0.064	0.047	4,269	0.583	1	7,104

Table 3: Investment Cash Flow Sensitivity and Tangibility: Baseline Model

This table displays OLS-FE (firm and year effects) estimation results of the augmented investment regression model (Eq. (14) in the text). All data are from the annual COMPUSTAT industrial tapes. The sampled firms include only manufacturers (SICs 2000-3999) and the sample period is 1971 through 2000. The estimations correct the error structure for heteroskedasticity and clustering using the White-Huber estimator. t-statistics (in parentheses).

PANEL A: TANGIBILITY PROXYED BY FIRM-LEVEL LIQUIDATION VALUES (BASED ON BERGER ET AL. (1996))

Dependent Variable	Independent Variables				R^2	N
Investment	Q	*CashFlow*	*Tangibility*	*CashFlow*× *Tangibility*		
FINANCIAL CONSTRAINTS CRITERIA						
1. PAYOUT POLICY						
Constrained Firms	0.0631*	−0.1031*	−0.1145**	0.3579*	0.104	8,531
	(6.31)	(−6.14)	(−2.48)	(6.37)		
Unconstrained Firms	0.0131*	0.1713	−0.0951	0.0232	0.121	9,037
	(2.92)	(1.80)	(−1.32)	(0.15)		
2. FIRM SIZE						
Constrained Firms	0.0342*	−0.1705*	−0.3004*	0.5846*	0.104	8,423
	(4.38)	(−12.83)	(−6.82)	(13.03)		
Unconstrained Firms	0.0311*	0.1948*	0.0817	−0.1203	0.111	9,341
	(4.18)	(2.91)	(1.23)	(−0.87)		
3. BOND RATINGS						
Constrained Firms	0.0394*	−0.1199*	−0.3334*	0.4238*	0.097	16,392
	(5.86)	(−6.36)	(−6.55)	(7.02)		
Unconstrained Firms	0.0328*	0.0733	−0.0448	0.1426	0.118	12,950
	(5.40)	(1.53)	(−1.04)	(1.58)		
4. COMMERCIAL PAPER RATINGS						
Constrained Firms	0.0440*	−0.1153*	−0.2491*	0.4138*	0.095	22,238
	(6.82)	(−6.50)	(−6.53)	(8.16)		
Unconstrained Firms	0.0208*	0.1576*	−0.0193	0.0825	0.156	7,104
	(3.99)	(2.77)	(−0.34)	(0.72)		

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

Table 3: — Continued

PANEL B: TANGIBILITY PROXYED BY INDUSTRY-LEVEL ASSET LIQUIDITY (BASED ON REDEPLOYMENT OF USED CAPITAL)

Dependent Variable	Independent Variables				R^2	N
Investment	Q	*CashFlow*	*Tangibility*	*CashFlow*× *Tangibility*		
FINANCIAL CONSTRAINTS CRITERIA						
1. PAYOUT POLICY						
Constrained Firms	0.0557* (4.79)	0.0638* (3.54)	−0.0944 (−1.42)	0.4027** (2.53)	0.088	6,917
Unconstrained Firms	0.0135** (2.13)	0.2037* (8.10)	−0.0101 (−0.13)	−0.2045 (−1.06)	0.116	6,759
2. FIRM SIZE						
Constrained Firms	0.0315* (4.07)	0.0767* (4.07)	−0.1525** (−2.08)	0.3872** (2.14)	0.065	6,118
Unconstrained Firms	0.0353* (3.81)	0.1054** (2.28)	−0.1199 (−1.30)	0.1481 (0.57)	0.102	7,017
3. BOND RATINGS						
Constrained Firms	0.0426* (6.20)	0.0996* (4.33)	−0.1405 (−1.79)	0.3656 (1.85)	0.103	13,282
Unconstrained Firms	0.0333* (4.14)	0.1107* (3.91)	−0.1720* (−2.57)	0.2275 (1.32)	0.101	8,467
4. COMMERCIAL PAPER RATINGS						
Constrained Firms	0.0467* (6.96)	0.0902* (4.88)	−0.1532** (−2.54)	0.4062* (2.61)	0.099	17,480
Unconstrained Firms	0.0169* (2.69)	0.2245* (7.09)	−0.0992 (−1.43)	−0.1648 (−0.92)	0.167	4,269

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

Table 3: — Continued

PANEL C: TANGIBILITY PROXYED BY PRODUCT DURABILITY (BASED ON SHARPE'S (1994) INDUSTRY DEFINITIONS)

Dependent Variable	Independent Variables				R^2	N
Investment	*Q*	*CashFlow*	*Tangibility*	*CashFlow*× *Tangibility*		
FINANCIAL CONSTRAINTS CRITERIA						
1. PAYOUT POLICY						
Constrained Firms	0.0953* (7.62)	0.1105* (3.98)	−0.0565* (−6.10)	0.0875* (2.61)	0.112	8,556
Unconstrained Firms	0.0075 (1.76)	0.1520* (10.08)	0.0040 (0.55)	−0.0545** (−2.42)	0.176	9,065
2. FIRM SIZE						
Constrained Firms	0.0444* (5.04)	0.1518* (8.69)	−0.0511* (−7.36)	0.1412* (7.08)	0.066	8,448
Unconstrained Firms	0.0338* (4.22)	0.0869* (2.64)	0.0066 (0.56)	−0.1326* (−3.61)	0.242	9,369
3. BOND RATINGS						
Constrained Firms	0.0589* (7.07)	0.1010* (5.61)	−0.0450* (−4.32)	0.0737* (2.60)	0.089	16,439
Unconstrained Firms	0.0327* (5.04)	0.1569* (8.98)	−0.0326* (−3.46)	−0.0097 (−0.36)	0.168	12,986
4. COMMERCIAL PAPER RATINGS						
Constrained Firms	0.0624* (7.80)	0.1120* (6.80)	−0.0485* (−4.52)	0.0771** (2.50)	0.092	22,310
Unconstrained Firms	0.0205* (3.26)	0.1603* (7.23)	−0.0120 (−1.13)	−0.0548 (−1.68)	0.224	7,115

Notes: *,** indicate statistical significance at the 1- and 5-percent (two-tail) test levels, respectively. Regressions include year-fixed effects only.

Table 4: Robustness Checks: Alternative Specifications

This table displays results for OLS and GMM estimations using alternative versions of the baseline regression model (Eq. (14) in the text). All estimations control for firm- and year-fixed efffects. The reported estimates are the coefficients returned for $CashFlow \times Tangibility$. All data are from the annual COMPUSTAT industrial tapes. The sampled firms include only manufacturers (SICs 2000-3999) and the sample period is 1971 through 2000. The estimations correct the error structure for heteroskedasticity and clustering using the White-Huber estimator. t-statistics (in parentheses).

Dependent Variable *Investment*	Financial Constraints Criteria			
	Payout Policy	Firm Size	Bond Ratings	CP Ratings
Proposed Change to Baseline Specification				
1. Adding one lag of sales growth [OLS]				
Constrained Firms	0.2958*	0.5406*	0.3935*	0.3852*
	(5.60)	(11.60)	(6.36)	(7.59)
Unconstrained Firms	0.0772	−0.1071	0.1359	0.0946
	(0.45)	(−0.74)	(1.44)	(0.85)
2. Adding lags of Q [OLS]				
Constrained Firms	0.3052*	0.5715*	0.4391*	0.4230*
	(4.76)	(12.53)	(5.51)	(6.90)
Unconstrained Firms	0.0912	−0.0734	0.1534	0.0726
	(0.50)	(−0.45)	(1.53)	(0.60)
3. Instrumenting Q with lagged Q and sales growth [GMM]				
Constrained Firms	0.3109*	0.5820*	0.4569*	0.4377*
	(4.62)	(12.23)	(5.50)	(6.81)
Unconstrained Firms	0.0970	−0.0691	0.1570	0.0762
	(0.54)	(−0.43)	(1.55)	(0.65)
4. Instrumenting Q with analysts' earnings forecasts [GMM]				
Constrained Firms	0.4843*	0.5454*	0.4134*	0.3574*
	(4.09)	(5.15)	(3.93)	(3.39)
Unconstrained Firms	−0.1470	−0.1053	0.1184	0.0566
	(−0.78)	(−0.58)	(1.09)	(0.47)

Table 4: — Continued

Dependent Variable *Investment*	Financial Constraints Criteria			
	Payout Policy	Firm Size	Bond Ratings	CP Ratings
Proposed Change to Baseline Specification				
5. Lagging cash flow, tangibility, and the interaction term [OLS]				
Constrained Firms	0.2161**	0.2015**	0.1065	0.1780**
	(2.39)	(1.99)	(0.95)	(2.34)
Unconstrained Firms	0.1213	0.0279	0.2359	0.0894
	(1.59)	(0.19)	(2.82)*	(0.61)
6. Adding (and instrumenting) changes in working capital [GMM]				
Constrained Firms	0.1332**	0.2766*	0.2021*	0.2105*
	(2.07)	(4.04)	(2.97)	(3.98)
Unconstrained Firms	−0.0232	−0.2723	−0.2120	−0.9549*
	(−0.14)	(−1.40)	(−1.64)	(−2.78)
7. Adding (and instrumenting) lags of investment, sales, debt [GMM]				
Constrained Firms	0.1382**	0.2428**	0.2509*	0.1329**
	(2.19)	(1.96)	(4.08)	(2.19)
Unconstrained Firms	0.4726*	0.0026	−0.1153**	−0.0058
	(9.93)	(0.05)	(−2.44)	(−0.12)
8. Quantile regression				
Constrained Firms	0.3677*	0.5914*	0.2254*	0.4834*
	(6.76)	(7.22)	(4.42)	(8.28)
Unconstrained Firms	0.2507*	0.0067	0.0876	0.1954**
	(3.36)	(0.09)	(1.19)	(2.21)

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

Table 5: Fixed Capital and R&D Expenditures: Two-Stage Estimator

This table displays IV-FE (firm and year effects) estimation results from the R&D expenditure model (Eq. (25) in the text). All data are from the annual COMPUSTAT industrial tapes. The sampled firms include only manufacturers (SICs 2000-3999) and the sample period is 1971 through 2000. The first-stage regressions R^2 are displayed. The estimations correct the error structure for heteroskedasticity and clustering using the White-Huber estimator. t-statistics (in parentheses).

Dependent Variable	Independent Variables				R^2	N
Investment	$\widehat{I}$	*CashFlow*	*Tangibility*	*CashFlow* × *Tangibility*		
Financial Constraints Criteria						
1. Payout Policy						
Constrained Firms	0.6291*	0.0590	0.5439*	−0.2004	0.117	5,302
	(4.00)	(1.40)	(5.58)	(−1.43)		
Unconstrained Firms	−0.6574	0.2634	−0.0267	−0.0345	0.110	5,960
	(−1.35)	(1.65)	(−0.17)	(−0.11)		
2. Firm Size						
Constrained Firms	0.7221*	0.1696*	0.7440*	−0.5785*	0.108	4,708
	(4.02)	(3.70)	(6.57)	(−3.72)		
Unconstrained Firms	0.5929**	0.1601	0.1306	−0.3278	0.115	7,114
	(2.00)	(1.01)	(1.04)	(−0.97)		
3. Bond Ratings						
Constrained Firms	0.6120*	0.0186	0.4626*	−0.0703	0.110	9,816
	(3.50)	(0.41)	(4.07)	(−0.46)		
Unconstrained Firms	0.5617*	0.1638**	0.2587*	−0.4017**	0.125	9,000
	(3.47)	(2.31)	(3.43)	(−2.47)		
4. Commercial Paper Ratings						
Constrained Firms	0.6924*	0.0423	0.4613*	−0.1526	0.110	13,346
	(4.64)	(1.15)	(5.74)	(−1.25)		
Unconstrained Firms	0.4167	0.2571**	0.1664	−0.5006**	0.156	5,470
	(1.71)	(2.45)	(1.38)	(−1.93)		

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

Table 6: Macroeconomic Dynamics: Two-Step Estimator of the Impact of Shocks to Aggregate Activity on Investment–Cash Flow Sensitivities

The dependent variable is the (fisrt-stage) estimated interaction between cash flow and tangibility (see Eq. (14) in the text). In each estimation, the dependent variable is regressed on three lags of the change in log real GDP ($\Delta Log(GDP)$ from Eq. (29)). Regressions also include a constant, changes in inflation (CPI), changes in basic interest rates (Fed funds rate), and a time trend. The sampled firms include only manufacturers (SICs 2000-3999) and the sample period is 1971 through 2000. The sum of the coefficients for the lags of the GDP are shown along with the p-values for the sum. Exclusion test rows report the p-values for the rejection of the hypothesis that the lags of GDP do not forecast the dependent variable. Heteroskedasticity- and autocorrelation-consistent errors are computed with a Newey-West lag window of size four. The standard errors for cross-equation differences are computed via a SUR system that estimates the group regressions jointly.

		Financial Constraints Criteria			
		Payout Policy	Firm Size	Bond Ratings	CP Ratings
1. Constrained Firms					
	Sum of GDP Coefficients	9.816	7.015	1.555	2.790
	Summation Test (p-value)	0.00	0.08	0.63	0.33
	Exclusion Test (p-value)	0.00	0.04	0.20	0.03
2. Unconstrained Firms					
	Sum of GDP Coefficients	−3.181	−13.374	−2.116	−6.913
	Summation Test (p-value)	0.55	0.00	0.69	0.02
	Exclusion Test (p-value)	0.38	0.00	0.00	0.00
3. Diff. Constrained−Unconstrained					
	Sum of GDP Coefficients	12.997	20.749	3.671	9.703
	Summation Test (p-value)	0.02	0.01	0.35	0.08