# Financial Constraints, Asset Tangibility, and Corporate Investment*

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## Abstract

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 investment in pledgeable assets. We show that this credit multiplier has a significant effect on investment when firms face credit constraints. Specifically, investment–cash flow sensitivities will be increasing in the degree of tangibility of financially constrained firms' assets. If firms are unconstrained, however, 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 helps address the concern that inferences based on investment–cash flow sensitivities are biased when Q does a poor job in controlling for investment opportunities. We implement our testing strategy on a large sample of manufacturing firms drawn from COMPUSTAT between 1971 and 2000. Using standard OLS and measurement error-consistent GMM estimators, we find that 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, errors-in-variables, GMM.

JEL classification: G31.

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# Financial Constraints, Asset Tangibility, and Corporate Investment

## Abstract

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 investment in pledgeable assets. We show that this *credit multiplier* has a significant effect on investment when firms face credit constraints. Specifically, investment–cash flow sensitivities will be *increasing* in the degree of tangibility of financially constrained firms' assets. If firms are unconstrained, however, 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 helps address the concern that inferences based on investment–cash flow sensitivities are biased when *Q* does a poor job in controlling for investment opportunities. We implement our testing strategy on a large sample of manufacturing firms drawn from COMPUSTAT between 1971 and 2000. Using standard OLS and measurement error-consistent GMM estimators, we find that the data strongly support our hypothesis about the role of asset tangibility on corporate investment under financial constraints.

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# 1 Introduction

Whether financing frictions influence real investment decisions is a central matter in contemporary financial economics (see Stein (2003)). A number of theories explore the interplay between financing frictions and investment to study issues ranging from firm 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 easy task. In an influential paper, Fazzari et al. (1988) proposed that when firms face external financing constraints their investment spending should vary not only with the availability of profitable opportunities, but also with the availability of internal funds. Accordingly, one should be able to gauge the effect of financing frictions on corporate investment by comparing the sensitivity of investment to cash flow across samples of financially constrained and unconstrained firms. Examining empirical investment–cash flow sensitivities has since become the standard in the literature that investigates the direct impact of capital markets imperfections on investment.[1] And their use has also become widespread in the corporate finance literature. Investment–cash flow sensitivities are one of the key metrics used for drawing inferences about efficiency in internal capital markets (Lamont (1997) and Shin and Stulz (1998)), the effect of agency on corporate spending (Blanchard et al. (1994), Hadlock (1998), and Bertrand and Mullainathan (2004)), the role of business groups in capital allocation (Hoshi et al. (1991)), and the influence of managerial characteristics on corporate policies (Bertrand and Schoar (2003) and Malmendier and Tate (2003)), among other issues.

Some recent papers, however, have pointed to limitations in the strategy proposed by Fazzari et al. (1988). Kaplan and Zingales (1997) question the usefulness of investment–cash flow sensitivities in assessing the effects of financing constraints, arguing that the Fazzari et al. hypothesis is not a necessary implication of optimal investment under constrained financing. The authors also report empirical results that contradict Fazzari et al.'s findings that more financially constrained firms have higher investment–cash flow sensitivities. Gomes (2001) and Alti (2003) propose that cross-sectional variations in the informational content of cash flows regarding investment opportunities could generate the patterns reported by Fazzari et al. even in the absence of financing frictions. Cummins et al. (1999) and Erickson and Whited (2000) further argue that differences in investment–cash flow sensitivities across constrained and unconstrained firms could be explained by a model in which investment spending depends only on investment opportunities, but where those

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

opportunities are empirically measured with error. These various arguments have put into question one's ability to draw inferences about the relationship between financing frictions and investment by looking at empirical investment–cash flow sensitivities.

In this paper we develop and test a theoretical argument that allows us to identify whether financing imperfections affect firm investment behavior. We build on the extant literature 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 strategy is to recognize that variables that increase a firm's ability to contract external finance will influence 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 contractibility problems — asset tangibility increases the value that can be recaptured by creditors in default states.[2] Through a simple contracting model, we show that investment–cash flow sensitivities will be *increasing* in the tangibility of constrained firms' assets. But in contrast, tangibility will have *no effect* on investment–cash flow sensitivities of financially unconstrained firms. This theoretical prediction allows us to formulate an empirical test of the interplay between financial constraints and investment that uses a "differences in differences"-type 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 basic intuition is as follows. Consider examining the impact of a cash flow innovation on investment spending within a cross-section of financially constrained firms — that is, firms that are unable to exhaust their profitable investment opportunities due to credit market 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 stems from an endogenous change in external finance capacity: for a given change in investment, the change in borrowing capacity will be *larger* 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 differences in investment–cash flow sensitivities across financially constrained firms. Because the credit multiplier will be greater when assets have higher tangibility, constrained firms that invest in more tangible assets will be

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[2] Our empirical proxies for asset tangibility do not simply measure the ratio of tangible to intangible assets in the firm's balance sheet, but rather gauge the *degree of salability* or the *ease of redeployment* of a firm's assets by its creditors (hereinafter, the term "tangibility" is meant to summarize these characteristics).

more sensitive to cash flow shocks. According to the same logic, though, asset tangibility will have no effect on the investment policy of firms that are able to exhaust their profitable investments opportunities (i.e., financially unconstrained firms).

The main innovation of our paper is to recognize and explore the feedback effect of investment upon financing frictions that is generated by an income shock. The upshot of considering a second dimension in which financing frictions manifest themselves is that we can then sidestep some of the problems associated with earlier work on financial constraints. Because we focus on the *differential effect* of asset tangibility on 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 poor proxies for investment opportunities (such as $Q$) are used. To wit, while problems with proxy quality might imply a different bias for the absolute *levels* of the estimated investment–cash flow sensitivities across constrained and unconstrained samples, our empirical test is less subject to those (level) biases in that we focus on the *marginal* effect of tangibility on investment sensitivities exploring an independent financing–investment mechanism (the credit multiplier).

As we show in detail below, in order to generate our hypothesis in a model with frictionless financing, one would have to explain why the residuals from poor proxies for investment opportunities will load onto variations in asset tangibility across samples of financially constrained and unconstrained firms precisely along the lines of our predictions. Although it is difficult to articulate an economic rationale for such a story, one could still make a case for unsigned biases in our tests based on measurement errors coupled with asymmetries in the joint distribution of the empirical variables used in our regressions across samples. For example, in the context of the Fazzari et al. (1988) test, Erickson and Whited (2000) have shown that sample differences in the variance of cash flows alone may generate differences in cash flow sensitivities across constrained and unconstrained firms when $Q$ is measured with error. Since we use $Q$ in our basic estimations, it is possible that similar statistical issues may bias the inferences that we make using the credit multiplier mechanism — *any* regression using $Q$ may be subject to such a bias. Accordingly, we employ the measurement error-consistent estimator proposed by Erickson and Whited (2000), the GMM estimator proposed by Cummins et al. (1999), and the Euler-based empirical model of capital investment suggested by Bond and Meghir (1994) to ensure that our empirical results are not explained away by mismeasurement in investment opportunities.[3]

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[3] The main reason why financial constraints are deemed "not necessary" to generate investment–cash flow sensitivities in the numerical simulations of Gomes (2001) and Alti (2003) is that those simulations use average $Q$ as a (poorly-measured) proxy for investment opportunities. Hence, empirical methods that are robust to the presence of measurement error in $Q$ also address the main criticisms raised by those authors. Gomes also argues that financial

We test our hypothesis on a large sample of manufacturing firms drawn from the COMPUSTAT tapes between 1971 and 2000. In doing so, we estimate investment equations for subsample partitions that are based on the likelihood that firms face constrained access to capital markets. These empirical equations resemble those of Fazzari et al. (1988), but include an interaction term that captures the effect of tangibility on investment–cash flow sensitivities. We use various alternative approaches suggested by the literature in assigning observations into groups of constrained and unconstrained firms. These are based on characteristics related to firm payout policy, 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. The results are identical whether we use traditional OLS or measurement error-consistent GMM estimators.

The effect of asset tangibility on constrained firms' investments seems to have sizeable economic significance. For example, while a one-standard-deviation shock to cash flow increases annual investment spending by approximately 3 to 5 cents (per dollar of fixed capital) for firms at the first decile of our base measure of asset tangibility, the same shock increases investment by approximately 8 to 13 cents for firms at the ninth decile of that tangibility measure. Asset tangibility drives no discernible patterns in investment when financially unconstrained firms are hit by a similar cash flow innovation. Importantly, all of our inferences hold after we subject our estimations to a number of robustness checks involving changes to the empirical specification, variable construction, sample selection criteria, and use of alternative econometric techniques.

In order to pin down the constrained-investment phenomena we want to study, we conduct most of our tests using a detailed firm-level measure of asset tangibility. This empirical proxy suits our tests in that it gauges the expected liquidation value of firms' main categories of operating assets in every year of our sample. However, one could argue that to the extent that a firm may "pick" its asset tangibility, those firms that are more likely to be financially constrained could endogenously choose to invest in assets that are easier to collateralize. Although we believe that the nature of the firm production process will largely determine the firm's asset allocation across fixed capital, inventories, accounts receivable, etc., there could indeed exist some degree of endogeneity in firm-level measures of tangibility. To ensure that an "endogenous asset tangibility" story does not generate our results, we use additional industry-level measures of tangibility throughout the analysis

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constraints are "not sufficient" to generate empirical patterns in investment–cash flow sensitivities. However, if such patterns do exist in the data and cannot be ascribed to measurement errors, this critique becomes a moot point.

— while it is plausible that firm-level measures could partly capture endogenous firm responses to financing frictions, this is an unlikely case for our industry-level proxies. As it turns out, our inferences are the same whether we use firm- or industry-level proxies to measure tangibility.

As a check of the logic of our results, we 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 helps us identify whether some sort of estimation bias (or model "hard-wiring") could produce results that go in the same direction of the multiplier effect even when, in principle, no such effect should exist. To perform this experiment, we develop a test for the cash flow sensitivity of R&D investment (which presumably creates little or no collateral value) that accounts for endogenous fixed capital investment. We find no evidence that our tangibility measures boost the effect of cash flow shocks on R&D investment.[4]

In the final part of our analysis we pursue the implications of the credit multiplier argument even further, looking at the effect of macroeconomic movements 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 (e.g., Bernanke et al. (1996)). 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 credit for investment spending. In the context of our testing strategy, we should observe a more pronounced impact of tangibility on constrained firms' investment–cash flow sensitivities during economic expansions 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 Campello (2003). We find that macroeconomic innovations lead to shifts in the marginal effect of tangibility on investment–cash flow sensitivities that exactly agree with our credit multiplier hypothesis.

Our study is not the first attempt at designing a testing 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. As argued by Gilchrist and Himmelberg (1995), however, one must notice that the Euler equation approach is unable to identify the presence of constraints when firms are as constrained today as they are in the

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[4] 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 (see, e.g., Gomes (2001)). Our testing strategy is less subject to this criticism: it does not return estimates that are suggestive of frictions (through the multiplier) in settings where we do not expect the multiplier to operate.

future. Moreover, this approach might reject the null of perfect capital markets for reasons other than financing frictions, such as misspecification in production technologies and adjustment costs (see Fazzari and Petersen (1993)). Blanchard et al. (1994) and Lamont (1997), on the other hand, explore "natural experiments" to bypass the need to control for investment opportunities in investment equations featuring cash flows. But one limitation of the natural experiment approach is the difficulty in generalizing the findings derived from this test strategy to different empirical settings.[5] The methodology we propose in this paper, in contrast, can be used in a number of different contexts in which financing constraints might play a role in influencing firm investment.[6]

Our paper's findings are related to other strands of the literature. For instance, variations in asset tangibility and recovery rates have been used to explain variations in capital structure (e.g., Rajan and Zingales (1995)), to examine interactions between financial development, industry growth and short-run fluctuations in production (Claessens and Laeven (2003), Braun (2003), Braun and Larrain (2004)), to study the debt-overhang problem (Hennessy (2004)), and in the valuation of abandonment options by firm 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 firm investment when financing is constrained.

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 identify 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.

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[5] See Rosenzweig and Wolpin (2000) for a discussion of this and other limitations of natural experiments.

[6] Almeida et al. (2003) propose replacing investment spending with cash holdings in tests of financial constraints and using cash flow sensitivities of cash as measures of the effect of financial constraints on firm policies. While those authors interpret their findings as evidence of financing frictions, they do not examine real investment spending.

## 2.1 Analysis

The economy has 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.[7] 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. $\tau$ 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.[8] Firms with high $\tau$ are able to borrow more because they invest in assets whose value can be largely recaptured by outside investors in liquidation states.

Creditors' valuation of assets in liquidation, $\tau I$, will establish the borrowing constraint faced by the firm[9]

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

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 investment. Besides the new investment opportunity, we suppose that the firm also has an amount $W$ of internal funds available for investment.

The entrepreneur chooses new investment, $I$, and new debt, $B$, in order to maximize the value

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

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

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

of the equity, which equals the sum of the dividends paid at times $0$ and $1$. Assuming that the discount rate is equal to zero, the entrepreneur's program can be written as:

$$\max_{I} \; f(I) - I \text{ s.t.}$$
$$I \leq W + \tau I.$$

The first-best level of investment is given by

$$f'(I^{FB}) = 1, \tag{2}$$

which will be feasible so long as

$$W + \tau I^{FB} \geq I^{FB}. \tag{3}$$

In words, when internal funds and borrowing capacity are sufficiently high the unconstrained, efficient level of investment is achieved. However, investment will be constrained ($I < I^{FB}$) when

$$W < W(\tau) = (1-\tau)I^{FB}. \tag{4}$$

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 then:

$$\begin{aligned} I(W,\tau) &= \frac{W}{(1-\tau)}, \text{ if } W < W(\tau) \\ &= I^{FB}, \text{ if } W \geq W(\tau). \end{aligned} \tag{5}$$

And investment–cash flow sensitivities are given by:

$$\begin{aligned} \frac{\partial I}{\partial W}(W,\tau) &= \frac{1}{(1-\tau)}, \text{ if } W < W(\tau) \\ &= 0, \text{ if } W \geq W(\tau). \end{aligned} \tag{6}$$

Eq. (6) shows that the investment–cash flow sensitivity increases with the tangibility of investment when the firm is financially constrained (that is $\frac{\partial^2 I}{\partial W \partial \tau} > 0$, 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. To wit, consider the effect of a positive cash flow shock that increases $W$ for two constrained firms with different levels of tangibility, $\tau$. The change in the availability of internal funds, $\Delta W$, has a direct effect on constrained investment, which is the same for both firms (equal to $\Delta W$). 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 $\tau$ firm. In other words, asset tangibility will amplify the effect of exogenous income shocks on the investment spending of financially constrained firms. Eq. (6) 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, $\frac{\partial I}{\partial W}$, bears the following relationship with asset tangibility:

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

ii) $\frac{\partial I}{\partial W}$ 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 external credit capacity following a cash flow shock is higher for those constrained firms whose assets are more tangible. 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 theory.

### 2.2.1 Tangibility and financial status

Proposition 1 states that tangibility should only affect the investment policy of financially constrained firms. However, notice that tangibility itself could help determine whether a firm will be constrained in the first place — that is, whether $W < W(\tau)$ — since $W(\tau)$ is decreasing in $\tau$. Of course, whether a firm is constrained or not also depends on factors other than asset tangibility. Accordingly, in the empirical analysis, we follow previous researchers in exploring variations in these other factors when assigning firms into constrained and unconstrained groups. Yet, one might consider what happens when tangibility and financial status 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, further increases in tangibility might no longer affect investment sensitivities because the firm becomes unconstrained. This argument suggests that the effect of tangibility on investment–cash flow sensitivities (when it exists) should be driven primarily by firms whose assets have relatively low tangibility. We examine this argument in our empirical tests.

### 2.2.2 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: What elements 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 observe. Bernanke et al. (1996) explore yet another rationale, namely, agency problems, in their version of the credit multiplier. Finally, in another version of the model (available upon request) we use Holmstrom and Tirole's (1997) theory of moral hazard in project choice to derive similar implications — our predictions are not particular to the assumption that human capital is inalienable.

### 2.2.3 Robustness of the main result: quantity *versus* cost constraints

In Section 2.1 we implicitly assumed that firms cannot raise outside equity or uncollateralized 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 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 even if firms can raise external finance beyond the limit implied by the quantity constraint. Naturally, a condition that is required for this to hold is that that if firms raise finance beyond the limit supported by collateral they pay a (deadweight) cost in addition to the fair cost of raising funds. If firms can raise an unlimited amount of external funds without paying a premium they become unconstrained. In addition, a reasonable assumption is that the marginal cost of external funds is increasing in the amount of uncollateralized finance that the firm is raising (as in Froot et al. (1993) and Kaplan and Zingales (1997)).[10]

Under these conditions, the relation between tangibility and the multiplier arises from the

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[10] Froot et al. show that this assumption arises from first principles in a costly-state-verification framework.

simple observation that having more collateral reduces the cost premium associated with external funds. If tangibility (and thus collateral) are 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 creates higher collateralized debt capacity. In other words, tangibility moderates the increase in the cost of external finance following a shock that boosts investment. If tangibility is low, on the other hand, then the cost of borrowing increases much more rapidly, since the firm has to tap more expensive sources of finance in order to fund the new investment. Because increases in financing costs dampen the effect of a cash flow shock, investment will tend to respond more to a cash flow shock when the tangibility of the underlying assets is high. Thus, a similar multiplier operates in a cost-based version of the model (a detailed derivation is available from the authors).[11]

# 3 Empirical Tests

The main empirical implication of our model can be summarized as follows. If a firm is financially constrained and credit capacity is related to collateral, then investment–cash flow sensitivities will increase with asset tangibility. In particular, a positive shock to cash flow will boost investment spending for all constrained firms, but the effect of the income shock will be largest for those constrained firms whose investments create the most borrowing capacity. If the firm is unconstrained, on the other hand, investment is 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 identify financially constrained and unconstrained firms. We will tackle these issues shortly, but first we describe our data.

## 3.1 Sample

Our sample selection approach is roughly similar to that of 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, and plant property and equipment (capital

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[11] The only novelty of the cost-based version with respect to the model presented above is that in the cost-based model there could be countervailing effects related to changes in the curvature of the production function, which could act in the opposite direction of the multiplier. For example, the marginal benefit of investment tends to be smaller for high tangibility firms when the production function is highly concave, because these firms invest more in equilibrium. Empirically, these effects would make it harder for us to estimate a positive relationship between tangibility and cash flow sensitivities. The extent to which countervailing effects could attenuate the multiplier is a question that we leave to the data.

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 $Q$ or with $Q$ in excess of 10. 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 those firm-years registering large jumps in business fundamentals (size and sales); these are typically indicative of mergers, reorganizations, and other major corporate events. The third data cut-off is introduced as a first, crude attempt to address problems in the measurement of investment opportunities in the raw data.[12]

Most studies in the extant literature use relatively short data panels and require firms to provide observations during the entire time period under investigation (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. Following Bond and Meghir (1994), we instead require that firms only enter our sample if they appear for at least five consecutive years in the data. Our 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.[13] Our empirical model is written as:

$$\begin{aligned} Investment_{i,t} &= \alpha_1 Q_{i,t-1} + \alpha_2 CashFlow_{i,t} + \alpha_3 Tangibility_{i,t} \\ &\quad + \alpha_4 \left(CashFlow \times Tangibility\right)_{i,t} + \sum_i firm_i + \sum_t year_t + \varepsilon_{i,t}, \end{aligned} \tag{7}$$

where $firm$ and $year$ capture firm- and year-specific effects, respectively.

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[12] These same cut-offs for $Q$ are used by Gilchrist and Himmelberg and we find that their adoption reduces the average $Q$ in our sample to about 1.0; only slightly lower than studies that use our same data sources and definitions but that do not impose bounds on the empirical distribution of $Q$ (Kaplan and Zingales (1997) report an average $Q$ of 1.2, while Polk and Sapienza (2002) report 1.5).

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

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. Similarly to their paper, we estimate liquidation values for the firm-years in our sample via the computation:

$$\mathsf{Tangibility} = 0.715 \times \mathsf{Receivables} + 0.547 \times \mathsf{Inventory} + 0.535 \times \mathsf{Capital},$$

where Receivables is COMPUSTAT item #2, Inventory is item #3, and Capital is item #8. Following Berger et al., we add the value of cash holdings (item #1) to this measure and scale the result by total book assets. Although we believe that the nature of the firm production process will largely determine the firm's asset allocation across fixed capital, inventories, etc., there could be some degree of endogeneity in this measure of tangibility. In particular, one could argue that whether a firm is constrained might affect its investments in more tangible assets and thus its credit capacity. The argument for an endogenous bias in our tests along these lines, nonetheless, becomes a very unlikely proposition when we use either of the following two measures of tangibility.

The second measure of tangibility we use is a time-variant, industry-level proxy whose purpose is to gauge the degree of asset redeployability. More precisely, the proxy is intended to capture the ease with which lenders can liquidate a firm's productive capital. Following Kessides (1990) and Worthington (1995), we measure asset redeployment using the ratio of used to total (i. e., used plus new) fixed depreciable capital expenditures in an 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 was first proposed by Shleifer and Vishny (1992). To construct the intended measure, we hand-collect data for used and new capital acquisitions at the four-digit SIC level from the Bureau of Census' Economic Census. 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 Census series using the most timely information on the industry ratio of used to total capital expenditures for every firm-year throughout our sample period.[14] Estimations based on this measure of tangibility use smaller sample sizes since not all of COMPUSTAT's SIC codes are in the Census data.

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[14] For example, we use the 1982 Census 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 data available from the 1992 Census.

The third measure of asset tangibility we consider is similar to the measure just discussed in that we attempt to gauge creditors' ability to readily dispose of a firm's assets. Here, too, we use an industry-level indicator of ease of liquidation. Based on the well-documented high cyclicality of durables goods industry sales, we use a durable/nondurable industry 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 (i.e., other firms in the same industry). To wit, because durables goods producers are highly cycle-sensitive, negative shocks to demand will likely affect all best alternative users of a durables producer's assets, decreasing tangibility. Our third measure of tangibility is an indicator variable that assigns firm-years to "more" and "less" tangible industries based on the scheme 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 conjecture that the assets of firms operating in nondurables (durables) industries are perceived as more (less) liquid by lenders, and assign to firms in these industries the value of 1 (0).using this proxy do not allow for firm-fixed effects.

We refer to Eq. (7) 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. (7) 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 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 $\alpha_2 + \alpha_4 \times \text{Tangibility}$. Differently from other papers in the literature, the estimate returned for $\alpha_2$ 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 lies outside of the empirical distribution of our basic measure of tangibility. The summary statistics reported in Table 2 below will aid in the interpretation of our estimates.

### 3.2.2 The use of $Q$ in investment demand equations

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 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)).

We believe that these problems do not have a first-order effect on the inferences about constrained investment that we can make with our test. The standard argument in the theoretical literature (Gomes (2001), and Alti (2003)), is that $Q$ can be a comparatively worse proxy for investment opportunities for firms typically classified as financially constrained.[15] As we explain in detail below, our proposed testing strategy deals directly with this source of bias, because our empirical test is independent of the level of the estimated cash flow coefficients of constrained and unconstrained firms. However, as Erickson and Whited (2000) discuss, differential measurement issues with $Q$ are not the only possible source of bias in the standard Fazzari et al. (1988) tests. In order to clarify these issues, and to be more precise about how our empirical strategy deals with the potential biases in investment–cash flow regressions, we now introduce a bit of notation.

Although in our specification we interact cash flow with tangibility for constrained and unconstrained firms, to build intuition, it is more convenient to think about a split sample approach in which we run the basic Fazzari et al. regression for four different categories of firms. These groups consist of constrained firms with low and high tangibility, and of unconstrained firms with low and high tangibility ($2 \times 2$ groups).[16] Dropping time and year subscripts and ignoring fixed effects, the empirical model that we seek to estimate is simply:

$$I = a + \alpha CF + \beta Q + /, \tag{8}$$

where $CF$ is cash flow, $a$ a constant term, $/$ represents an error term, and $Q$ represents an (unobservable) measure of true investment opportunities. The main problem is that we do not observe the true investment opportunities, but only an imperfect proxy, $Q$. Now, assume that the classic errors-in-variables model holds, that is:

$$Q = Q + e, \tag{9}$$

where $e$ is an error term which is assumed to be independent of $Q$, $CF$, $/$, and also of the proxies for tangibility and the constrained/unconstrained dummies. Erickson and Whited (2000) show that an OLS estimation of Eq. (8) produces the following probability limits for the coefficients of interest $\alpha$ and $\beta$:

$$\text{plim}(\beta_{OLS}) = \beta\lambda_x^2 \tag{10}$$

$$\text{plim}(\alpha_{OLS}) = \alpha + (\beta - \beta_{OLS})\mu, \tag{11}$$

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[15] This possibility was originally suggested by Poterba (1988) in his discussion of Fazzari et al. (1988).

[16] This introspection is akin to Erickson and Whited (2000), who interact cash flow with constrained/unconstrained dummies in their specifications but use a split-sample approach to explain the intuition for their results.

where $\mu$ is the slope coefficient of a regression of $Q$ on a constant term and $CF$, and $\lambda_x^2$ (the "attenuation bias") is a fraction between $0$ and $1$ given by

$$\lambda_x^2 = \frac{Var(r_x)}{Var(r_x) + Var(e)}, \tag{12}$$

where $r_x$ is the residual of a regression of $Q$ on $CF$ and a constant term. Notice that when $Var(e)$ is zero there is no measurement error, hence thus $\lambda_x^2 = 1$ and both $\alpha_{OLS}$ and $\beta_{OLS}$ are unbiased. Furthermore, the attenuation bias depends not only on the pure measurement error in $Q$ (the variance term $Var(e)$), but also on the degree of collinearity between $Q$ and the perfectly measured variables in the model (captured by $Var(r_x)$). To cut clutter, we rewrite $(\beta - \beta_{OLS}) = \Delta\beta_{OLS}$.

Assume that the main coefficient of interest is the cash flow sensitivity, $\alpha_{OLS}$. Clearly, if there is measurement error in $Q$, and provided that $\mu > 0$ (that is, cash flow and $Q$ are positively correlated), then $\alpha_{OLS}$ will be an upwardly biased estimate of the true $\alpha$. Recall, the traditional Fazzari et al. (1988) test consists of comparing $\alpha_{OLS}$ for constrained and unconstrained firms, and making inferences about financial constraints based on the difference in $\alpha_{OLS}$ across these groups of firms. In this case, the bias induced by measurement error can be written as

$$\text{p}\lim(\alpha_{OLS}^{con} - \alpha_{OLS}^{unc}) - (\alpha^{con} - \alpha^{unc}) = \Delta\beta_{OLS}^{con}\mu^{con} - \Delta\beta_{OLS}^{unc}\mu^{unc}, \tag{13}$$

where the superscripts represent the fact that these statistics and parameters are calculated for constrained and unconstrained firms separately. It is useful to decompose the right-hand side of this expression (the bias in the Fazzari et al. test) in the following way:

$$\Delta\beta_{OLS}^{con}\mu^{con} - \Delta\beta_{OLS}^{unc}\mu^{unc} = (\Delta\beta_{OLS}^{con} - \Delta\beta_{OLS}^{unc})\mu^{con} + \Delta\beta_{OLS}^{unc}(\mu^{con} - \mu^{unc}). \tag{14}$$

This simple formula can illustrate some of the issues with the Fazzari et al. test that have been discussed in the literature. For example, Alti's (2003) model suggests that $Q$ could be a comparatively worse measure of investment opportunities for the types of firms usually classified as constrained. He shows that this systematic difference arises naturally from a model in which younger firms face uncertainty about their growth prospects and this uncertainty is resolved through time. In terms of the equations above, this argument suggests that the attenuation bias would be stronger for constrained firms, and thus $(\Delta\beta_{OLS}^{con} - \Delta\beta_{OLS}^{unc}) > 0$. This differential measurement error can explain some of findings in the literature, because cash flow sensitivities of investment will tend to be higher in sample of "constrained" firms, even when the true difference in cash flow sensitivities $(\alpha^{con} - \alpha^{unc})$ is equal to zero.

Although differential measurement error tends to be emphasized in the literature, it is clearly not the only possible source of bias. The second term in Eq. (14) illustrates this point. Even when $\Delta\beta^{con}_{OLS} - \Delta\beta^{unc}_{OLS} = 0$, the difference in cash flow sensitivities will be biased in the presence of measurement error if $(\mu^{con} - \mu^{unc}) \neq 0$. For example, Erickson and Whited (2000) find that even though the degree of the attenuation bias seems to be constant across the samples of constrained and unconstrained firms that they use (and thus the first term in (14) would equal zero), $(\mu^{con} - \mu^{unc}) < 0$ in their sample because the variance of cash flows is much larger in the sample of constrained firms (recall that $\mu = \frac{cov(Q,CF)}{Var(CF)}$).[17] This second type of bias might occur for purely statistical reasons, and thus it is hard to use economic intuition in order to derive expectations about the particular direction of the bias.

**Our proposed estimation.** Our proposed strategy does not consist of comparing the cross-sectional difference $(\alpha^{con}_{OLS} - \alpha^{unc}_{OLS})$, as in Fazzari et al. Rather, we look at $(\alpha^{con,highT}_{OLS} - \alpha^{con,lowT}_{OLS})$, where $highT$ stands for high tangibility and $lowT$ stands for low tangibility for constrained firms, while using $(\alpha^{unc,highT}_{OLS} - \alpha^{unc,lowT}_{OLS})$ as a comparison benchmark. Keeping our same notation, the bias associated with the first difference in sensitivities for constrained firms is:

$$\text{p}\lim(\alpha^{con,highT}_{OLS} - \alpha^{con,lowT}_{OLS}) - (\alpha^{con,highT} - \alpha^{con,lowT}) = \Delta\beta^{con,highT}_{OLS}\mu^{con,highT} - \Delta\beta^{con,lowT}_{OLS}\mu^{con,lowT}. \tag{15}$$

Following the analysis above, this bias can be decomposed in the following way:

$$(\Delta\beta^{con,highT}_{OLS} - \Delta\beta^{con,lowT}_{OLS})\mu^{con,highT} + \Delta\beta^{con,lowT}_{OLS}(\mu^{con,highT} - \mu^{con,lowT}). \tag{16}$$

The first term reflects the possibility that the bias afflicting the $Q$ coefficient is systematically related to the tangibility proxies that we use. While we do not deny this possibility, recall that our proposed test also verifies whether the estimated effect of tangibility on cash flow sensitivities is zero for unconstrained firms. The associated bias in the unconstrained sample is given by:

$$(\Delta\beta^{unc,highT}_{OLS} - \Delta\beta^{unc,lowT}_{OLS})\mu^{unc,highT} + \Delta\beta^{unc,lowT}_{OLS}(\mu^{unc,highT} - \mu^{unc,lowT}). \tag{17}$$

Thus, in order to argue that a systematic relationship between tangibility and the bias afflicting the $Q$ coefficient is driving our results (that is, that the term $\Delta\beta^{highT}_{OLS} - \Delta\beta^{lowT}_{OLS}$ is positive), one would have to explain why this systematic relationship affects firms in the constrained sample, but has no effect on firms in the unconstrained sample. If $\Delta\beta^{highT}_{OLS} - \Delta\beta^{lowT}_{OLS}$ is positive for both samples, we would tend to observe that tangibility also affects cash flow sensitivities of the unconstrained firms,

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[17] Recall also from the formula for the attenuation bias that differences in the sampling distribution of the main variables might also cause this bias to differ across groups of firms, even when there are no differences in the underlying measurement error processes (that is, even when $Var(e)$ is the same across samples).

even though the theory suggests that the true effect $(\alpha^{unc,highT} - \alpha^{unc,lowT})$ should be zero. Although one could propose a story that goes in this direction, we are unaware of any such arguments in the literature. Clearly, because our proposed test is independent of the overall difference in cash flow sensitivities across constrained and unconstrained subsamples, biases afflicting the difference $(\alpha^{con}_{OLS} - \alpha^{unc}_{OLS})$ that were suggested in previous some papers (e.g., Alti (2003)) do not necessarily translate into problems for our test.

As we discussed above, however, estimation biases could also arise from purely statistical reasons, such as the unknown properties of the joint distribution of the main variables under study. For example, it could well be that the difference in the slope coefficients $(\mu^{highT} - \mu^{lowT})$ is positive for constrained firms (and only for these firms). Thus, we cannot completely rule out the possibility that *some* property of the joint statistical distribution of the variables in our analysis, coupled with $Q$-measurement error, might introduce estimation biases that are difficult to sign. Because of this indeterminacy, in the empirical section we experiment with several techniques that can produce reliable estimates even when $Q$ is mismeasured. First, we use the measurement error-consistent GMM estimator suggested by Erickson and Whited (2000). We further follow Cummins et al. (1999) and estimate our baseline model using a GMM estimator that uses financial analysts' earnings forecasts as instruments for $Q$. Finally, we estimate Bond and Meghir's (1994) Euler-based empirical model of capital investment, which entirely dispenses with the need to include $Q$ in the set of regressors. All of these estimators confirm the reliability of our results (see Section 3.5).

## 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 of constraints one should 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 approach used by Gilchrist and Himmelberg (1995) and Almeida et al. (2003):[18]

- 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

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[18] Notice that our first two classification schemes allow firms to move across groups. Since one could argue that movements across groups may happen frequently (which we have verified to not hold in the data) and endogenous (which is difficult to ascertain) we also perform all of our tests using partitions on size and payout that are determined in the pre-sample period and are held fixed over time. These schemes lead to immaterial changes in our results.

ratio of total distributions (dividends plus stock repurchases) to operating income; hence firms that do not pay dividends but engage in substantial stock repurchase programs are not classified as constrained. The intuition that financially constrained firms have significantly lower payout ratios follows from Fazzari et al. (1988), among others.[19]

- Scheme #2: We rank firms based on their total assets through the 1971–2000 period and assign to the financially constrained (unconstrained) group those firms in the bottom (top) three deciles of the asset size distribution. The rankings are again performed on an annual basis. This approach resembles Gilchrist and Himmelberg (1995) and Erickson and Whited (2000), who also distinguish between groups of financially constrained and unconstrained firms on the basis of size rankings. The argument for size as a good observable measure of financial constraints is that small firms are typically young, less well known, and thus more vulnerable to capital market imperfections.
- Scheme #3: We retrieve data on firms' bond ratings and categorize those firms that never had their public debt rated during our sample period as financially constrained.[20] 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 Whited (1992), Kashyap et al. (1994), and Gilchrist and Himmelberg (1995), among others. 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 one of the eight financial constraint categories used in our analysis. According to the payout scheme, for example, there are 9,819 financially

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[19] 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. 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 0.23.

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

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. The third measure, nonetheless, suggests that constrained firms actually have less tangible assets.

TABLE 2 ABOUT HERE

Table 3 reports summary statistics for firm investment, $\mathsf{Q}$, and cash flows, separately for firms with the highest and lowest tangibility levels. The purpose of this table is to check whether there are distributional patterns in those three variables that are systematically related with asset tangibility. Recall, we use three measures of asset tangibility. The first is based on a firm-level proxy for expected value of assets in liquidation and the second on an industry-level measure of asset redeployment. These two measures are continuous and we categorize as "low-tangibility" ("high-tangibility") firms those firms ranked in the bottom (top) three deciles of the tangibility distribution; these rankings are performed on an annual basis. The third tangibility measure is based on Sharpe's (1994) industry durability, where low-tangibility (high-tangibility) firms are simply those in the durables (nondurables) industries. Table 3 suggests the absence of any systematic patterns for investment demand, investment opportunities, and cash flows across low- and high-tangibility firms. For example, while high-tangibility firms seem to invest more and have higher cash flows according to the first two tangibility proxies, the opposite is true when the third proxy is used.

Table 3 about here

## 3.4 Results

Table 4 presents the results returned from the estimation of our baseline regression model (Eq. (7)) within each of the above sample partitions and for each of our three tangibility proxies. The baseline model is estimated via OLS with firm- and year-fixed effects,[21] and the error structure (estimated via Huber-White) allows for residual heteroskedasticity and time clustering. A total of 8 estimated equations (4 constraints criteria × 2 constraints categories) are reported in each of the 3 panels in the table, yielding 12 constrained–unconstrained comparison pairs. Since we use interaction terms in all of our regressions and because one of the variables used to gauge interaction effects (namely, Tangibility) is defined differently across our estimations, we shall carefully discuss the economic meaning of all of the estimates we report in panels A through C.

Table 4 about here

Firstly, notice that **each and every one** of the 12 regression pairs in Table 4 reveals the same key 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. These central findings are fully consistent with the presence of a multiplier effect for constrained firm investment that works along the lines of our model.

To illustrate the economic impact of asset tangibility on the sensitivity of investment to cash flows we use the most conservative estimates in panel A of Table 4 (the payout sample split). Notice that when calculated at the first decile of Tangibility (i.e., at 0.43) the partial effect of a one-standard-deviation cash flow innovation (which is equal to 0.61) on investment over capital is about 3.1 cents, while at the ninth decile of the same measure (0.63) that partial effect equals 7.6 cents ($t$-statistic of 8.25).[22] Analogous calculations for unconstrained firms yield mostly economically and statistically insignificant effects. Because we are not strictly estimating structural investment

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[21] 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 (time-invariant) industry category.

[22] The partial effects are equal to the standard deviation of cash flows times the coefficient on CashFlow, plus that standard deviation times the coefficient on the interaction term times the level of Tangibility (first or ninth decile).

equations, these economic magnitudes should be interpreted with some caution. Yet, they ascribe an important role for the credit multiplier in shaping the investment behavior of constrained firms.

Secondly, notice that the coefficients on CashFlow are negative in some of the estimations of panel A of Table 4, but positive in the estimations in panels B and C. This sign reversal is due to the impact of the (tangibility-) "interaction" effect on the "main" regression effect of cash flows; recall Tangibility is a quite different regressor across the estimations in those panels. Importantly, the estimates in panel A do not suggest that positive cash flow shocks are detrimental to firm investment. To see this, note that although CashFlow attracts a negative coefficient, in order for cash flow to hamper investment, Tangibility should equal zero (or be very close to zero), which as one can infer from Table 2, is a point outside the empirical distribution of our firm-level measure of tangibility.[23] Indeed, when we compute the partial effect of cash flows on investment we find that these effects are positive even at very low levels of tangibility. On the other hand, Tangibility is often either very small or exactly zero when the industry-level measures of asset tangibility are used in the estimations. In those estimations, CashFlow obtains a positive significant coefficient, consistent with the idea that cash flow shocks will boost investment even when tangibility is low. Our estimates also suggest that the coefficients for CashFlow are larger for the unconstrained firm regressions than for the constrained firm regressions. For example, while the cash flow coefficient of the payout-unconstrained sample is 0.17, the implied cash flow coefficient of the payout-constrained sample at the average tangibility level is only 0.09. Noteworthy, these same "counter-Fazzari et al." cash flow results are found in a number of previous studies, such as Kadapakkam et al. (1998), Cummins et al. (1999), Cleary (1999), and most noticeably, in Erickson and Whited (2000).

The remaining coefficients in Table 4 also display patterns that are consistent with our story and with previous research, but they, too, may deserve further discussion. For instance, note that the coefficients for Q are in the very same range of those reported by Gilchrist and Himmelberg (1995) and Polk and Sapienza (2002), among other comparable studies. Those coefficients tend to be larger for the constrained firms, a pattern also seen in some of the estimations in Fazzari et al. (1988), Hoshi et al. (1991), and Cummins et al. (1999). The coefficient returned for Tangibility, $\alpha_3$, is negative in many of our estimations, although often statistically insignificant. In interpreting this result, the reader must recognize that the estimate of $\alpha_3$ captures the correlation between asset tangibility and investment when cash flow is zero. When we estimate the implied effect of tangibility on investment with other regressors held at the average, we obtain effects that are mostly positive, but sometimes

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[23] The Least Squares estimator for interactive models will produce vector coefficients for the "main" effects of the interacted variables even when those effects accrue to data points that lie outside of the actual sample distribution.

negative, depending on the particular subsample. The partial impact of tangibility is economically very small. For example, we estimate that for average cash flow levels a one-standard-deviation change in tangibility increases investment by less than 0.001 cents in the payout-constrained subsample, and decreases investment by 0.009 cents in the size-constrained subsample. These small direct effects suggest that the main impact of asset tangibility on corporate investment is associated with its indirect role in amplifying the effect of cash flows shocks through a multiplier mechanism.

### 3.5 Robustness

We subject our findings to a number of robustness checks in order to address potential concerns about empirical biases, model specification, and other estimation issues. We report the results from these checks in Tables 5 and 6. To save space, we only present the estimates returned for the interaction term $\mathsf{CashFlow} \times \mathsf{Tangibility}$. For ease of exposition, we focus our discussion on the results associated with our first proxy for asset tangibility.[24]

The first sort of empirical biases we address concerns the potential problem with measurement errors in our proxy for investment opportunities, $\mathsf{Q}$. We investigate the possibility that mismeasurement in $\mathsf{Q}$ may affect our previous inferences by using the estimators of three papers that empirically tackle this issue: Erickson and Whited (2000), Cummins et al. (1999), and Bond and Meghir (1994). Results from these GMM estimators (including the associated Hansen's $\mathsf{J}$-statistics for overidentification restrictions) are presented in Table 5.

Table 5 about here

The first row of Table 5 displays the interaction term coefficients we obtain from the estimator labeled GMM5 in Erickson and Whited (2000); this uses up to four higher-order moment conditions for identification (as opposed to conditional mean restrictions).[25] One difficulty we find in applying the estimator proposed by Erickson and Whited is isolating observations that are suitable for their procedure. We can only isolate windows of three consecutive years after subjecting our data to those authors' sample "pre-tests," and these windows cover different stretches of our sample period.[26] Using more restricted data and a very different estimator, we find that the previous results

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[24] The full set of regression estimates, including those from the other two measures of tangibility, are available from the authors. The use of the alternative (industry-level) tangibility measures renders qualitatively similar results.

[25] We implement the GAUSS codes made available by Toni Whited in her Webpage.

[26] Erickson and Whited, too, report these sampling difficulties in their paper; their sample is constrained to a four-year window. Differently from their paper, our specification contains a proxy for tangibility and a cash flow–tangibility interaction term. This complicates our search for a stretch of data that passes their estimator's pre-tests. We could only find suitable samples of both financially constrained and unconstrained firms by dividend payout over the 1998–2000 window. The other partitions' estimation windows are: size (1983–1985), bond ratings (1985–1987), and commercial paper ratings (1980–1982).

continue to hold for each of our constraint criteria (although the estimation of the size-partitioned samples seems poorer). These results are reassuring to us in that they suggest that mismeasurement in empirical Q does not seem to translate into biased inferences about the income multiplier effect of asset tangibility.[27]

In the second row, we follow Cummins et al. (1999) and Abel and Eberly (2001), and use financial analysts' forecasts of earnings as an instrument for Q in a GMM estimation of our empirical model. As in Almeida et al. (2003), we employ the median forecast of the two-year ahead earnings scaled by lagged total assets to construct the earnings forecast measure. The earnings data come from I/B/E/S, where more extensive data coverage only starts in 1984. Although only some 52% of the firm-years in our original sample provide valid observations for earnings forecasts, our basic results remain nearly intact.

In row 3 of Table 5, we experiment with the Euler-type investment demand model proposed by Bond and Meghir (1994), by adding the lag of investment, its square, the lagged ratio of sales to capital, and the squared, 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. A noticeable feature of this empirical model is the absence of Q from the set of regressors — estimates are free from issues concerning mismeasurement in Q. Results in row 3 show that our conclusions about the multiplier effect on constrained investment continue to hold.

Next, we subject our baseline model to specification changes and to outlier robust estimations. The first column of Table 6 details the changes we impose to Eq. (7) at each estimation round. In the first row of the table, we add one lag of log sales growth to the model. The strategy of adding this type of extra control was commonly used by earlier studies (e.g., Fazzari et al. (1988) and Himmelberg and Petersen (1994)) as a way of ameliorating 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 extra lags of Q, cash flow, and sales growth (unreported).

<u>TABLE 6 ABOUT HERE</u>

In row 2, 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 Tangibility and the interaction term. While this seems to produce some changes in the equation estimates, our conclusions continue to hold for all but one of the sample splits (bond ratings).

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[27] Although our p-values for the rejection of the null of orthogonality conditions seem low, they are comparable to those in Hennessy (2004), who also uses the Erickson and Whited's (2000) GMM5 estimator.

In row 3, 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 the 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[28] to our specification and, following Fazzari and Petersen, instrument this added choice variable with the beginning-of-period stock of working capital.[29] This new round of estimations yields results that are similar to those of our base model.

Finally, because of concerns with the possibility of extreme outliers having undue influence on our results, we estimate our models via quantile regression. Row 4 of Table 6 indicates that our inferences cannot be ascribed to the effects of outlying observations.

### 3.6 Tangibility and Constraint Status

As we discussed in Section 2.2.1, 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 suggests that, at very high levels of tangibility, further increases in tangibility should no longer affect investment sensitivities. In this section, we examine this possibility by using cross-sectional variations in asset tangibility as an alternative way of splitting 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 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 subsample by fitting Eq. (7) separately on 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:

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

where the coefficient on the interaction term is significant at the 1% level (t-stat of 5.36). In

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

[29] 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.

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 small and statistically insignificant.

These results are consistent with our basic hypothesis that tangibility boosts investment–cash flow sensitivities for constrained firms, also suggesting 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 marginal effect on investment 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 for the purpose of verifying whether our inferences are warranted. Looking at different types of investment expenditures for the firms in our sample might allow us to check 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 firm investment into components that differ according to their level of tangibility. On the other hand, COMPUSTAT provides data on one type of investment whose tangibility level is arguably very 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 and thus entail no multiplier effect. 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. Hence, 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 further evidence that a credit multiplier effect — which is absent from investment in intangibles — drives our 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. Suppose 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:

$$\max [f(I) - I + g(I_{R\&D}) - I_{R\&D}] \text{ s.t.} \tag{18}$$
$$\begin{aligned} I + I_{R\&D} &\leq W + B \\ B &\leq \tau I \end{aligned}$$

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:

$$f'(I^{FB}) = g'(I^{FB}_{R\&D}) = 1. \tag{19}$$

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 (18) for $I = I^{FB}$ and $I_{R\&D} = I^{FB}_{R\&D}$. Otherwise, the firm will be financially constrained. The constrained solution to the firm's problem is given by investment levels $I$ and $I_{R\&D}$ that satisfy:[30]

$$\begin{aligned} f'(I) &= (1-\tau)g'(I_{R\&D}) + \tau \\ W &= (1-\tau)I + I_{R\&D}. \end{aligned} \tag{20}$$

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 because hard assets add to the firm's debt capacity, relaxing financing constraints. In order to facilitate the implementation of the model we suppose that the marginal productivity functions are linear:[31]

$$f'(I) = a - bI \qquad \text{and} \qquad g'(I_{R\&D}) = c - dI_{R\&D}. \tag{21}$$

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

$$\begin{aligned} \alpha I - \beta_\tau I_{R\&D} &= \delta_\tau \\ (1-\tau)I + I_{R\&D} &= W, \end{aligned} \tag{22}$$

where the parameters $\alpha$, $\beta_\tau$, and $\delta_\tau$ can be solved out as functions of the production function parameters and of $\tau$.

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[30] We assume 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.

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

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:

$$I_{R\&D} = \frac{1}{1 + \frac{(1-\tau)\beta_{\tau}}{\alpha}} W - \frac{(1-\tau)\delta_{\tau}}{\alpha - (1-\tau)\beta_{\tau}}. \tag{23}$$

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

$$\frac{\partial I_{R\&D}}{\partial W} = \frac{1}{1 + \frac{(1-\tau)\beta_{\tau}}{\alpha}} = \frac{1}{1 + \frac{(1-\tau)^2 d}{b}}. \tag{24}$$

Importantly, 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. Since this increase is greater when tangibility is higher, a firm with highly tangible 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. The equation that links the firm's sources and uses of funds can be solved out for $I_{R\&D}$ yielding:

$$I_{R\&D} = W - (1-\tau)I \ . \tag{25}$$

Thus, 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. 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 fixed 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 spending to cash flows and endogenous fixed investment (Eq. (25)).

This proposed strategy can be readily implemented within our framework by fitting our baseline investment equation (Eq. (7)) to the data in order to generate predicted fixed capital investment values (denoted by $\widehat{I}$) and then running a regression of $I_{R\&D}$ on $\widehat{I}$:

$$\begin{aligned} I_{R\&D i,t} \quad = \quad & \beta_1 \widehat{I}_{i,t} + \beta_2 CashFlow_{i,t} + \beta_3 Tangibility_{i,t} \\ & + \beta_4 \left(CashFlow \times Tangibility\right)_{i,t} + \sum_i firm_i + \sum_t year_t + \varepsilon_{i,t.} \end{aligned} \tag{26}$$

Note that we do not need to include proxies for investment opportunities in the set of regressors in Eq. (26). This allows us to use lagged $Q$ to identify the model.[32] Our hypothesis is that the effect of cash flow on R&D investment is *independent* of tangibility, even for constrained firms.

Table 7 reports the results from the estimation of Eq. (26). To help illustrate the adequacy of our 2SLS 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 4. 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 estimations or some "hard-wiring" in our specification leads to results that seem to agree with the multiplier effect even in the absence of the multiplier.

TABLE 7 ABOUT HERE

### 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 assets in their balance sheets can borrow and invest more.[33] This contrasts with what happens during recessions, when collateral values are sharply depressed

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

[33] 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. See Tirole (2001) for a simple formulation of this argument.

and the tangible nature of a firm's assets *per se* creates little or no (cross-sectional) differences in firms' ability to borrow and invest.[34] 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 the investment–cash flow sensitivities of financially constrained firms during booms (when collateral values are high) than in recessions (when collateral values collapse). Unconstrained firms' investment sensitivities, on the other hand, should remain invariant to shocks affecting collateral values.[35]

### 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 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.[36]

The first step of our procedure consists of estimating the baseline regression model (Eq. (7)) 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., $\alpha_4$) and 'stack' them into the vector $\Psi_t$, which is then used as the dependent variable in the following (second-stage) time series regression:[37]

$$\Psi_t = \eta + \sum_{k=1}^{3} \varphi_k \Delta Log(GDP)_{t-k} + \beta \Delta Log(CPI)_t + \lambda \Delta FF_t + \rho Trend_t + u_t. \tag{27}$$

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

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[34] When we say that tangibility is a less valuable characteristic 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; this firm's asset pledgeability might not be much higher than that of a firm with no tangible assets.

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

[36] An alternative one-step specification — with Eq. (27) below nested in Eq. (7) — would impose a more constrained parameterization 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.

[37] To see how this procedure accounts for the error contained in the first step, assume that the true $\Psi_t^*$ equals what is estimated from the first-step run ($\Psi_t$) plus some residual ($\nu_t$): $\Psi_t^* = \Psi_t + \nu_t$. One would like to estimate Eq. (27) 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. (27) uses $\Psi_t$ (rather than $\Psi_t^*$) on the right hand-side. Consequently, so long as $E[\mathbf{X}'\nu] = 0$, $\eta$ will absorb the mean of $\nu_t$, while $u_t$ will be a mixture of $\nu_t$ and $\omega_t$. 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 $\boldsymbol{\theta}$.

and the statistical significance of aggregate activity shocks can be gauged from the sum of the coefficients for the lags of GDP, $\sum \varphi_k$, and from the $t$-statistics of this sum. We also report $p$-values for the rejection of the hypothesis that GDP lags do not help forecast the impact of tangibility on sensitivities. We allow for lags of GDP changes 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.[38] 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.[39] 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 macro activity *only*. This could pose a problem to the identification strategy we want to exploit. Fortunately, our theory (and previous evidence) provides for a solution: since tangibility plays no determinant role in the investment of unconstrained firms, we can use those firms' responses to macroeconomic conditions in order to back out 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.[40]

### 3.8.3 Results

The results from the two-stage estimator are summarized in Table 8. The table reports the coefficients for $\sum \varphi$ from Eq. (27) 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

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[38] 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.

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

[40] 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.

estimated via a SUR system that combines the two constraint categories (*p*-values reported).

Table 8 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 statistical significance is not achieved in one estimation. 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 mechanism affects the sensitivity of corporate investment to cash flows.

## 4 Concluding Remarks

One of the most important research topics in financial economics is the question of whether financing frictions affect real investment. 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 flow and cash holdings affect corporate investment. Despite the plausibility of such a channel, previous literature has found it difficult to design an empirical test showing that financing frictions have direct, unambiguous effects on corporate investment.

Our study attempts to develop such a test. 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. Empirically, 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 have been associated with the traditional Fazzari et al.'s (1988) approach. We also show that our results remain whether we use traditional OLS or measurement error-consistent GMM estimators, demonstrating that our testing strategy is robust to the presence of measurement error in $Q$.

The evidence we uncover is consistent with a direct impact of financing frictions on corporate 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, while no such effects are observed for unconstrained firms. Our results are very robust. They hold for all of the different combinations of empirical proxies for financial constraints and tangibility that we are able to gather from the previous literature. Our conclusions also hold after we subject our estimations to a number of checks involving changes in empirical specifications and econometric methods. We also show in the data that the cash flow sensitivities of investment activities that entail no credit multiplier are 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 amplifying the impact of income shocks on firm investment. We believe that our testing approach will prove useful for future researchers in need of a reliable method of identifying the impact of financial constraints on investment, and in more general contexts where investment–cash flow sensitivities might help in drawing inferences about the interplay between capital markets and corporate behavior.

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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 | StDev | N | Mean | Median | StDev | N | Mean | Median | StDev | N |
| Financial Constraints Criteria | | | | | | | | | | | | |
| 1. Payout Policy | | | | | | | | | | | | |
| Constrained Firms | 0.545 | 0.557 | 0.088 | 9,819 | 0.071 | 0.058 | 0.050 | 8,144 | 0.411 | 0 | 0.492 | 9,819 |
| Unconstrained Firms | 0.534 | 0.547 | 0.088 | 9,745 | 0.068 | 0.053 | 0.052 | 7,275 | 0.538 | 1 | 0.499 | 9,745 |
| 2. Firm Size | | | | | | | | | | | | |
| Constrained Firms | 0.566 | 0.571 | 0.092 | 9,747 | 0.078 | 0.066 | 0.052 | 7,333 | 0.428 | 0 | 0.495 | 9,747 |
| Unconstrained Firms | 0.515 | 0.534 | 0.071 | 10,046 | 0.062 | 0.046 | 0.054 | 7,547 | 0.553 | 1 | 0.497 | 10,046 |
| 3. Bond Ratings | | | | | | | | | | | | |
| Constrained Firms | 0.559 | 0.567 | 0.093 | 19,504 | 0.072 | 0.059 | 0.055 | 15,929 | 0.469 | 0 | 0.500 | 19,504 |
| Unconstrained Firms | 0.519 | 0.536 | 0.080 | 12,950 | 0.067 | 0.051 | 0.051 | 8,467 | 0.506 | 1 | 0.499 | 12,950 |
| 4. Commercial Paper Ratings | | | | | | | | | | | | |
| Constrained Firms | 0.551 | 0.562 | 0.091 | 25,350 | 0.072 | 0.059 | 0.054 | 20,127 | 0.456 | 0 | 0.493 | 25,350 |
| Unconstrained Firms | 0.516 | 0.532 | 0.085 | 7,104 | 0.064 | 0.047 | 0.052 | 4,269 | 0.583 | 1 | 0.498 | 7,104 |

# Table 3: Summary Statistics of Investment, Q, and Cash Flow across Low and High Asset Tangibility Firms

This table displays summary statistics for investment, Q, and cash flows across groups of low- and high-tangibility firms. Investment is defined as the ratio of capital expenditures (COMPUSTAT item #128) to beginning-of-period capital stock (lagged item #8). Q is computed as the market value of assets divided by the book value of assets (= (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. There are three measures of asset tangibility. The first is based on a firm-level proxy for expected value of assets in liquidation and the second on an industry-level measure of asset redeployment. These two measures are continuous and we define as low-tangibility (high-tangibility) firms those firms ranked in the bottom (top) three deciles of the tangibility distribution. The third tangibility measure is based on Sharpe's (1994) industry "durability," where low-tangibility (high-tangibility) firms are those in the durables (nondurables) industries. The sampled firms include only manufacturers (SICs 2000–3999) and the sample period is 1971 through 2000.

| | Investment | | | | Q | | | | CashFlow | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Median | StDev | N | Mean | Median | StDev | N | Mean | Median | StDev | N |
| Asset Tangibility Measures | | | | | | | | | | | | |
| 1. Firm-Level Liquid. Values | | | | | | | | | | | | |
| Low-Tangibility Firms | 0.215 | 0.185 | 0.149 | 9,101 | 0.914 | 0.840 | 0.440 | 8,833 | 0.309 | 0.287 | 0.967 | 9,101 |
| High-Tangibility Firms | 0.261 | 0.210 | 0.199 | 9,697 | 0.991 | 0.809 | 0.777 | 9,557 | 0.439 | 0.384 | 0.466 | 9,697 |
| 2. Industry Redeployment | | | | | | | | | | | | |
| Low-Tangibility Firms | 0.243 | 0.193 | 0.200 | 5,872 | 0.917 | 0.811 | 0.486 | 5,337 | 0.319 | 0.259 | 0.426 | 5,872 |
| High-Tangibility Firms | 0.252 | 0.205 | 0.192 | 5,946 | 0.904 | 0.800 | 0.507 | 5,256 | 0.389 | 0.341 | 0.391 | 5,946 |
| 3. Industry Durability | | | | | | | | | | | | |
| Low-Tangibility Firms | 0.248 | 0.201 | 0.191 | 16,239 | 0.886 | 0.798 | 0.477 | 15,994 | 0.348 | 0.319 | 0.783 | 16,239 |
| High-Tangibility Firms | 0.219 | 0.189 | 0.151 | 15,186 | 0.962 | 0.823 | 0.627 | 15,081 | 0.339 | 0.289 | 0.350 | 15,186 |

# Table 4: 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. (7) 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 4: — 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* | 0.0638* | −0.0944 | 0.4027** | 0.088 | 6,917 |
| | (4.79) | (3.54) | (−1.42) | (2.53) | | |
| Unconstrained Firms | 0.0135** | 0.2037* | −0.0101 | −0.2045 | 0.116 | 6,759 |
| | (2.13) | (8.10) | (−0.13) | (−1.06) | | |
| 2. Firm Size | | | | | | |
| Constrained Firms | 0.0315* | 0.0767* | −0.1525** | 0.3872** | 0.065 | 6,118 |
| | (4.07) | (4.07) | (−2.08) | (2.14) | | |
| Unconstrained Firms | 0.0353* | 0.1054** | −0.1199 | 0.1481 | 0.102 | 7,017 |
| | (3.81) | (2.28) | (−1.30) | (0.57) | | |
| 3. Bond Ratings | | | | | | |
| Constrained Firms | 0.0426* | 0.0996* | −0.1405 | 0.3656 | 0.103 | 13,282 |
| | (6.20) | (4.33) | (−1.79) | (1.85) | | |
| Unconstrained Firms | 0.0333* | 0.1107* | −0.1720* | 0.2275 | 0.101 | 8,467 |
| | (4.14) | (3.91) | (−2.57) | (1.32) | | |
| 4. Commercial Paper Ratings | | | | | | |
| Constrained Firms | 0.0467* | 0.0902* | −0.1532** | 0.4062* | 0.099 | 17,480 |
| | (6.96) | (4.88) | (−2.54) | (2.61) | | |
| Unconstrained Firms | 0.0169* | 0.2245* | −0.0992 | −0.1648 | 0.167 | 4,269 |
| | (2.69) | (7.09) | (−1.43) | (−0.92) | | |

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

## Table 4: — Continued

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

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

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

## Table 5: Robustness Checks: Measurement Errors in $Q$

This table reports results from estimators used to address measurement errors in the proxy for investment opportunities, $\mathsf{Q}$, from the baseline regression model (Eq. (7) in the text). Each cell displays the estimates of the coefficients returned for $\mathsf{CashFlow}\times\mathsf{Tangibility}$ and the associated test statistics. The first set of estimations (row 1) uses the Erickson–Whited (2000) GMM5 estimator. The second set follows Cummins et al.'s (1999) GMM procedure where $\mathsf{Q}$ is instrumented with analysts' earnings forecasts (row 2). The estimator of row 3 is based on Bond and Meghir (1994), where lags of investment, sales, and debt are added as controls and instrumented (estimated via GMM). All estimations control for firm- and year-fixed effects. 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. $\mathsf{t}$-statistics (in parentheses). Hansen's $\mathsf{J}$-statistics for overidentifying restrictions tests [in square brackets].

| Dependent Variable | Financial Constraints Criteria | | | |
|---|---|---|---|---|
| Investment | Payout Policy | Firm Size | Bond Ratings | CP Ratings |
| 1. Erickson–Whited Estimator | | | | |
| Constrained Firms | 0.2330* | 0.4570 | 0.4100** | 0.8150** |
| | (2.59) | (1.36) | (2.46) | (2.49) |
| | [0.46] | [0.04] | [0.08] | [0.55] |
| Unconstrained Firms | 0.0600 | 0.1620 | 0.1720 | −0.4410 |
| | (0.26) | (0.41) | (0.97) | (1.12) |
| | [0.18] | [0.01] | [0.20] | [0.29] |
| 2. Cummins et al. Estimator | | | | |
| Constrained Firms | 0.4843* | 0.5454* | 0.4134* | 0.3574* |
| | (4.09) | (5.15) | (3.93) | (3.39) |
| | [0.36] | [0.28] | [0.12] | [0.18] |
| Unconstrained Firms | −0.1470 | −0.1053 | 0.1184 | 0.0566 |
| | (−0.78) | (−0.58) | (1.09) | (0.47) |
| | [0.32] | [0.25] | [0.22] | [0.14] |
| 3. Bond–Meghir Estimator | | | | |
| Constrained Firms | 0.1382** | 0.2428** | 0.2509* | 0.1329** |
| | (2.19) | (1.96) | (4.08) | (2.19) |
| | [0.11] | [0.22] | [0.18] | [0.11] |
| Unconstrained Firms | 0.1111 | 0.0026 | −0.1153** | −0.0058 |
| | (1.93) | (0.05) | (−2.44) | (−0.12) |
| | [0.17] | [0.18] | [0.09] | [0.08] |

Notes: *,** indicate statistical significance at the 1- and 5-percent (two-tail) test levels, respectively. $\mathsf{p}$-values reported for the Erickson–Whited estimator's $\mathsf{J}$-statistic are the sample annual medians.

Table 6: Robustness Checks: Alternative Specifications and Estimators

This table reports results for estimations using alternative versions and estimators of the baseline regression model (Eq. (7) in the text). Each cell displays the estimates of the coefficients returned for $CashFlow \times Tangibility$ and the associated test statistics. All estimations control for firm- and year-fixed effects. 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 | Financial Constraints Criteria | | | |
|---|---|---|---|---|
| Investment | 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*<br>(5.60) | 0.5406*<br>(11.60) | 0.3935*<br>(6.36) | 0.3852*<br>(7.59) |
| Unconstrained Firms | 0.0772<br>(0.45) | −0.1071<br>(−0.74) | 0.1359<br>(1.44) | 0.0946<br>(0.85) |
| 2. Lagging cash flow, tangibility, and the interaction term [OLS] | | | | |
| Constrained Firms | 0.2161**<br>(2.39) | 0.2015**<br>(1.99) | 0.1065<br>(0.95) | 0.1780**<br>(2.34) |
| Unconstrained Firms | 0.1213<br>(1.59) | 0.0279<br>(0.19) | 0.2359*<br>(2.82) | 0.0894<br>(0.61) |
| 3. Adding (and instrumenting) changes in working capital [GMM] | | | | |
| Constrained Firms | 0.1332**<br>(2.07) | 0.2766*<br>(4.04) | 0.2021*<br>(2.97) | 0.2105*<br>(3.98) |
| Unconstrained Firms | −0.0232<br>(−0.14) | −0.2723<br>(−1.40) | −0.2120<br>(−1.64) | −0.9549*<br>(−2.78) |
| 4. Quantile regression | | | | |
| Constrained Firms | 0.3677*<br>(6.76) | 0.5914*<br>(7.22) | 0.2254*<br>(4.42) | 0.4834*<br>(8.28) |
| Unconstrained Firms | 0.2507*<br>(3.36) | 0.0067<br>(0.09) | 0.0876<br>(1.19) | 0.1954**<br>(2.21) |

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

## Table 7: Fixed Capital and R&D Expenditures: Two-Stage Estimator

This table displays 2SLS-FE (firm and year effects) estimation results from the R&D expenditure model (Eq. (26) 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 8: Macroeconomic Dynamics: Two-Step Estimator of the Impact of Shocks to Aggregate Activity on Investment–Cash Flow Sensitivities

The dependent variable is the (first-stage) estimated interaction between cash flow and tangibility (see Eq. (7) 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. (27)). 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 |