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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 an important impact on investment when firms face credit constraints: investment-cash flow sensitivities are increasing in the degree of tangibility of constrained firms' assets. If firms are unconstrained, however, investment-cash flow sensitivities are unaffected by asset tangibility. Crucially, asset tangibility itself may determine whether a firm faces credit constraints - firms with more tangible assets may have greater access to external funds. This implies that the relationship between capital spending and cash flows is non-monotonic in the firm's asset tangibility. Our theory allows us to use a differences-in-differences approach to identify the effect of financing frictions on corporate investment: we compare the differential effect of asset tangibility on the sensitivity of investment to cash flow across different regimes of financial constraints. We implement this testing strategy on a large sample of manufacturing firms drawn from COMPUSTAT between 1985 and 2000. Our tests allow for the endogeneity of the firm's credit status, with asset tangibility influencing whether a firm is classified as credit constrained or unconstrained in a switching regression framework. 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 finance (Stein (2003)). Various 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. (2004)). Unfortunately, identifying financing–investment interactions in the data is not an easy task. The standard identification strategy is based on the methodology proposed by Fazzari et al. (1988).[1] Those authors argue that the sensitivity of investment to internal funds should increase with the wedge between the costs of internal and external funds (*monotonicity hypothesis*). Accordingly, one should be able to gauge the impact of credit imperfections on corporate spending by comparing the sensitivity of investment to cash flow across samples of firms sorted on proxies for financing frictions. A number of recent papers, however, have questioned the validity of the Fazzari et al. approach. Kaplan and Zingales (1997) argue that the monotonicity hypothesis is not a necessary implication of optimal investment under constrained financing, and report evidence that contradicts Fazzari et al.'s findings. Work by Erickson and Whited (2000), Gomes (2001), and Alti (2003) further suggests that the patterns reported by Fazzari et al. are consistent with models in which financing frictions play no role.

In this paper, we develop and test a theoretical argument that allows one to identify whether financing imperfections affect firm investment behavior. We explore the idea that variables that increase a firm's ability to contract external finance may influence observed investment spending when investment demand is constrained by credit 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 that draws on Kiyotaki and Moore (1997), we show that investment–cash flow sensitivities will be *increasing* in the tangibility of constrained firms' assets. In contrast, tangibility will have *no effect* on investment–cash flow sensitivities of financially unconstrained firms. Crucially, asset tangibility itself affects the credit status of the firm: firms with very tangible (pledgeable) assets are likely to become unconstrained. This implies a *non-monotonic effect* of tangibility on investment–cash flow sensitivities.

In a nutshell, our theory predicts that at relatively low levels of tangibility, the sensitivity of investment spending to cash flow increases with asset tangibility. However, this effect ceases to exist at high

[1] A partial list of papers that use the Fazzari et al. methodology 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.

[2] Our proxies for asset tangibility do not 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, rather than how *hard* are a firm's assets.

levels of tangibility, as highly tangible firms become financially unconstrained. This prediction allows us to formulate an empirical test of the interplay between financial constraints and investment that uses a differences-in-differences approach. We identify the effect of financing frictions on investment by comparing the differential effect of asset tangibility on the sensitivity of investment to cash flow across different (endogenously determined) regimes of financial constraints. In contrast to Kaplan and Zingales (1997), we argue that investment–cash flow sensitivities *can* be used as a means to gauge the impact of financing frictions on real investment. However, the conditions under which identification occurs also suggest that investment–cash flow sensitivities are *not* monotonically related to the degree of financing constraints. In this sense, the relationship between tangibility and investment–cash flow sensitivities that we identify agrees with Kaplan and Zingales's critique of the monotonicity hypothesis.

Our empirical approach provides a way to sidestep some of the problems associated with prior 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 in which poor proxies for investment opportunities (such as Q) are employed (cf. Erickson and Whited (2000) and Alti (2003)). We recognize that 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. However, our empirical test focuses on the *marginal* effect of asset tangibility on investment sensitivities. In order to generate our hypothesis in a model with frictionless financing, one would need to generate residuals from poor proxies for investment opportunities that have very special properties. Specifically, these residuals would need to load onto variations in asset tangibility differentially across samples of financially constrained and unconstrained firms, and do so precisely along the lines of the predictions of our theory. We find it difficult to articulate a good rationale for such a story. However, to verify that our empirical results cannot be explained away by mismeasurement and other biases, our analysis also employs the expectations GMM estimator proposed by Cummins et al. (1999), the measurement error-consistent estimator of Erickson and Whited (2000), and the Euler-based model of capital investment of Bond and Meghir (1994).

We test our hypothesis on a large sample of manufacturing firms drawn from the COMPUSTAT tapes between 1985 and 2000. We estimate investment equations that resemble those of Fazzari et al. (1988), but include an interaction term that captures the effect of tangibility on investment–cash flow sensitivities. These equations are fitted over subsamples that are identified based on the likelihood that firms face constrained access to capital markets. Importantly, our main tests do not rely on standard *a priori* assignments of firms into financial constraint categories. Instead, we look at cross-sectional differences in investment using a switching regression approach in which the probability that firms face constrained access to credit is jointly estimated with the investment equations. In this approach, we closely follow the prior work of Hu and Schiantarelli (1997) and Hovakimian and Titman (2004). However, in line with our theory, we also include asset tangibility as a determinant of the constraint status. To allow for comparability with existing research, in complementary tests we follow the bulk of the literature and assign observations into groups of constrained and unconstrained firms based on characteristics such as payout policy, size, bond ratings, and commercial paper ratings.

We conduct most of our tests using a detailed firm-level measure of asset tangibility (based on Berger et al. (1996)). This empirical proxy suits our analysis in that it gauges the expected liquidation value of firms' main categories of operating assets in every year of our sample (namely, liquid securities, accounts receivable, inventories, and fixed capital). However, because a firm's choices may affect the tangibility of its assets, there could exist some degree of endogeneity in firm-level measures of tangibility. To ensure that an "endogenous asset tangibility" story does not underlie our results, we use two additional industry-level measures of asset tangibility throughout the analysis.

Our tests show 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 sensitivities when firms are unconstrained. The results are identical whether we use maximum likelihood switching regression models, traditional OLS, or error-consistent GMM estimators, and for both firm- and industry-level tangibility proxies. In addition, consistent with our priors, the switching regression estimator suggests that higher tangibility makes it more likely that a firm will be classified as financially unconstrained. The effect of asset tangibility on constrained firms' investments is also economically significant. For example, a one-standard-deviation shock to cash flow increases annual investment spending by approximately 9 cents (per dollar of fixed capital) for firms at the first quartile of our base measure of asset tangibility. In contrast, the same shock increases investment by more than 20 cents for firms at the third quartile of that tangibility measure.

Our study is not the first attempt at designing a test strategy for financial constraints that tries to mitigate the problems in Fazzari et al. (1988). In that vein, Whited (1992) and Hubbard et al. (1995) adopt an Euler equation approach that recovers the intertemporal first-order conditions for investment across samples of constrained and unconstrained firms. As discussed by Gilchrist and Himmelberg (1995), however, the Euler equation approach is unable to identify constraints when firms are as constrained today as they are in the future. Moreover, this approach may reject the null of perfect capital markets for reasons other than financing frictions (e.g., misspecification in production technologies). Gertler and Gilchrist (1994) and Kashyap et al. (1994) compare the investment and inventory behavior of constrained and unconstrained firms over business and monetary policy cycles. Our methodology, in contrast, dispenses with the need to use exogenous macroeconomic movements to identify the impact of financing frictions on firm behavior. Blanchard et al. (1994), Lamont (1997), and Rauh (2006) explore "natural experiments" to bypass the need to control for investment opportunities in investment equations featuring cash flows. One limitation of their approach, however, is the difficulty in generalizing the findings derived from natural experiments across other empirical settings (see Rosenzweig and Wolpin (2000)). The methodology we propose, in contrast, can be used in a number of different contexts in which financing constraints might influence investment. Almeida et al. (2004) propose using the cash flow sensitivity of cash (as opposed to capital expenditures) to gauge the effect of financial constraints on firm policies. While Almeida et al. only relate financial constraints to a *financial* variable, this study helps establish a link between financing frictions and *real* corporate decisions. In all, the analysis of this paper provides a unique complement to the extant literature, suggesting new dimensions and ways in which to study the impact of financial constraints on real corporate behavior.

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

To identify the effect of tangibility on investment we study a simple theoretical framework in which firms have limited ability to pledge cash flows 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 2.2.1, however, our results do not hinge on the inalienability assumption.

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), if creditors have no bargaining power the contractual outcome in this framework is such that they will only lend up to the expected value of the firm in liquidation. 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 I can be recovered. τ is a natural function of the tangibility of the firm's physical assets and of other factors, such as the legal environment that dictates the relations between borrowers and creditors.[3] Firms with high τ are able to borrow more because they invest in assets whose value can be largely recaptured by creditors in liquidation states.

Creditors' valuation of assets in liquidation, τI, will establish the firm's borrowing constraint:

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

where B is the amount of new debt that is supported by the project. Besides the new investment opportunity, we suppose that the firm also has an amount W of internal funds available for investment.

The entrepreneur maximizes the value of new investment I. Assuming that the discount rate is equal to zero, the entrepreneur's program can be written as:

$$\max_{I} \; f(I) - I, \; s.t. \tag{2}$$

$$I \leq W + \tau I. \tag{3}$$

The first-best level of investment, I^{FB}, is such that $f^{'}(I^{FB}) = 1$. If the constraint in (3) is satisfied at I^{FB}, the firm is financially unconstrained. Thus, investment is constrained (i.e., $I^{*} < I^{FB}$) when

$$\tau < \tau^{*}(W, I^{FB}) = \max\left(1 - \frac{W}{I^{FB}}, 0\right). \tag{4}$$

Notice that $0 \leq \tau^{*}(W, I^{FB}) \leq 1$, and that if $I^{FB} - W < 0$ the firm is unconstrained irrespective of the level of τ (hence $\tau^{*} = 0$). If the firm is constrained, the level of investment is determined by the firm's budget (or credit) constraint. The general expression for the optimal level of investment is then:

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

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

And investment–cash flow sensitivities are given by:

$$\frac{\partial I}{\partial W}(W,\tau) = \frac{1}{(1-\tau)}, \text{ if } \tau < \tau^*(W, I^{FB}) \\ = 0, \text{ if } \tau \geq \tau^*(W, I^{FB}). \tag{6}$$

Eq. (6) shows that the investment–cash flow sensitivity is *non-monotonic* in the tangibility of the firm's assets. To be precise, 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 $\tau < \tau^*(W, I^{FB})$). However, if tangibility is high enough ($\tau \geq \tau^*(W, I^{FB})$), investment becomes insensitive to changes in cash flows.

The intuition for the positive relationship between tangibility and investment–cash flow sensitivities for constrained firms resembles that of the credit multiplier of Kiyotaki and Moore (1997). To wit, consider the effect of a positive cash flow shock that increases W for two constrained firms with different levels of tangibility, τ. The change in the availability of internal funds, ΔW, has a direct effect on constrained investment, which is the same for both firms (equal to ΔW). However, there is also an indirect effect that stems from the endogenous change in borrowing capacity (i.e., a relaxation in the credit constraint). This latter effect, which is equal to $\tau \Delta I$, implies that the increase in borrowing capacity will be greater for the high τ firm. In other words, asset tangibility will amplify the effect of exogenous income shocks on the investment spending of financially constrained firms. Naturally, if the firm's borrowing capacity is high enough, the firm becomes unconstrained and the investment–cash flow sensitivity drops to zero. This implies that further changes in tangibility will have no impact on the investment–cash flow sensitivity of a firm that is financially unconstrained. We state these results in a proposition that motivates our empirical strategy:

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

i) At low levels of tangibility ($\tau < \tau^*(W, I^{FB})$), the firm is financially constrained and $\frac{\partial I}{\partial W}$ increases in asset tangibility,

ii) At high levels of tangibility ($\tau \geq \tau^*(W, I^{FB})$), the firm is financially unconstrained and $\frac{\partial I}{\partial W}$ is independent of asset tangibility.

Whether the firm is financially constrained depends not only on asset tangibility, but also on other variables that affect the likelihood that the firm will be able to undertake all of its investment opportunities. In the model, these variables are subsumed in the cut-off $\tau^*(W, I^{FB})$. If τ^* is high, the firm is more likely to be financially constrained. The simple model we analyze suggests that τ^*

is increasing in the firm's investment opportunities (I^{FB}), and decreasing in the firm's availability of funds for investment (W). More generally, however, τ^* should be a function of other variables that affect the firm's external financing premium. Accordingly, the empirical analysis considers not only the variables used in the model above, but also other variables that prior literature has identified as being indicative of financing frictions.

2.2 Discussion

Before we move on to the empirical analysis, we discuss a few issues related to our theory.

2.2.1 Inalienability of human capital and creditor bargaining power

We used Hart and Moore's (1994) inalienability of human capital assumption to derive our main proposition. 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 it is not the only way to get at the credit multiplier. We could have just as well 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 an earlier version of the model we use Holmstrom and Tirole's (1997) theory of moral hazard in project choice to derive similar implications.

We also assumed that creditors have no bargaining power when renegotiating debt repayments with entrepreneurs. In this way, specified payments cannot exceed liquidation (collateral) values, which is the creditor's outside option. A similar link between collateral values and debt capacity is assumed in the related papers of Kiyotaki and Moore (1997) and Diamond and Rajan (2001), who in addition show that the link between debt capacity and collateral does not go away when creditors have positive bargaining power.

2.2.2 Quantity *versus* cost constraints

In Section 2.1 we 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. We note, however, that there will be a multiplier effect even if firms can raise external finance beyond the limit implied by the quantity constraint. The key condition that is required for the multiplier to remain operative is that raising external funds beyond this limit entails a deadweight cost of external finance (in addition to the fair cost of raising funds). A reasonable assumption supporting this story is that the marginal deadweight 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)).

Under the deadweight cost condition, the relation between tangibility and the multiplier arises from the simple observation that having more collateral reduces the cost premium associated with external funds. If tangibility is high, a given increase in investment has a lower effect on the marginal cost of total (i.e., collateralized and uncollateralized) external finance because it creates higher collateralized debt capacity. If tangibility is low, on the other hand, then the cost of borrowing increases very rapidly, as 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 (a detailed derivation is available from the authors).

3 Empirical Tests

To implement a test of Proposition 1, we need to specify an empirical model relating investment with cash flows and asset pledgeability. We will tackle this issue shortly. First we describe our data.

3.1 Data Selection

Our sample selection approach is roughly similar to that of Gilchrist and Himmelberg (1995), and Almeida et al. (2004). We consider the universe of manufacturing firms (SICs 2000–3999) over the 1985–2000 period with data available from COMPUSTAT's P/S/T and Research tapes on total assets, market capitalization, capital expenditures, cash flow, and plant property and equipment (capital stock). We eliminate firm-years for which the value of capital stock is less than $5 million, 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 and in order to improve the fitness of our investment demand model — Abel and Eberly (2001), among others, discuss the poor empirical fit of linear investment equations at high levels of Q.[4] We deflate all series to 1985 dollars using the CPI.

[4] 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

Many studies in the literature use relatively short data panels and require firms to provide observations during the entire 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 16-year-long sample would lead to obvious concerns with survivorship biases. We instead require that firms only enter our sample if they appear for at least three consecutive years in the data (this is the minimum number of years required for firms to enter our base regression models). Our sample consists of 18,304 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 with 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 $\times$ 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. 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. As we explain in detail below, our model estimation strategy allows the coefficient vector α to vary with the degree to which the firm faces financial constraints.

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 $\alpha_2 + \alpha_4 \times Tangibility$. Hence, in contrast to other papers in the literature, the estimate returned for α_2 alone says little about the impact of cash flow on investment. That coefficient represents the impact of cash flow when tangibility equals zero, a point that lies outside of the empirical distribution of our basic measure of asset tangibility. The summary statistics reported in Table 1 below will aid in the interpretation of our estimates.

of 1.2, while Polk and Sapienza (2004) report 1.6).

3.2.2 Model Estimation

To test our theory, we need to identify financially constrained and unconstrained firms. Following the work of Fazzari et al. (1988), the standard approach in the literature is to use exogenous, *a priori* sorting conditions that are hypothesized to be associated with the extent of financing frictions that firms face (see Erickson and Whited (2000), Almeida et al., (2004), and Hennessy and Whited (2005) for recent examples of this strategy). After firms are sorted into constrained and unconstrained groups, Eq. (7) could be separately estimated across those different categories.

One of the central predictions of our theory, however, is that the financial constraint status is *endogenously* related to the tangibility of the firm's assets. Hence, we need an estimator that incorporates the effect of tangibility *both* on cash flow sensitivities and on the constraint status. To allow for this effect, we follow Hu and Schiantarelli (1998) and Hovakimian and Titman (2004) and use a switching regression model with unknown sample separation to estimate our investment regressions. This model allows the probability of being financially constrained to depend on asset tangibility and on standard variables used in the literature (e.g., firm size, age, and growth opportunities). As explained next, the model simultaneously estimates the equations that predict the constraint status and the investment spending of constrained and unconstrained firms.

Our analysis takes the switching regression model as the baseline estimation procedure. However, for ease of replicability, and to aid in the comparability of our results with those in the previous literature, we also use the more traditional *a priori* constraint classification approach to test our story.[5]

The switching regression model (endogenous constraint selection) Hu and Schiantarelli (1998) and Hovakimian and Titman (2004) provide a detailed description of the switching regression estimator. Our approach follows theirs very closely, with the only difference being the use of asset tangibility as a predictor of financial constraints. Here we give a brief summary of the methodology.

Assume that there are two different investment regimes, which we denote by "regime 1" and "regime 2." While we take the number of investment regimes as given, the points of structural change are not observable and are estimated together with the investment equation for each one of the regimes. The model is composed of the following system of equations (estimated simultaneously):

$$I_{1it} = X_{it}\alpha_1 + \varepsilon_{1it} \tag{8}$$

$$I_{2it} = X_{it}\alpha_2 + \varepsilon_{2it} \tag{9}$$

$$y_{it}^{*} = Z_{it}\phi + u_{it}. \tag{10}$$

[5] An advantage of using the traditional approach is that some of our robustness tests can only be performed in this simpler setting, notably the use of measurement-error consistent GMM estimators that we describe in Section 3.5.

Eqs. (8) and (9) are the structural equations of the system; they are essentially two different versions of our baseline Eq. (7). We compress the notation for brevity, and let $X_{it} = (Q_{i,t-1}, CashFlow_{i,t}, Tangibility_{i,t}, (CashFlow \times Tangibility)_{i,t})$ be the vector of exogenous variables, and α be the vector of coefficients that relates the exogenous variables in X to investment ratios I_{1it} and I_{2it}. Differential investment behavior across firms in regime 1 and regime 2 will be captured by differences between α_1 and α_2.

Eq. (10) is the selection equation that establishes the firm's likelihood of being in regime 1 or regime 2. The vector Z_{it} contains the determinants of a firm's propensity of being in either regime. Observed investment is given by:

$$\begin{aligned} I_{it} &= I_{1it} \text{ if } y^*_{it} < 0 \\ I_{it} &= I_{2it} \text{ if } y^*_{it} \geq 0, \end{aligned} \tag{11}$$

where y^*_{it} is a latent variable that gauges the likelihood that the firm is in the first or the second regime.

The parameters α_1, α_2, and ϕ are estimated via maximum likelihood. In order to estimate those parameters it is assumed that the error terms ε_1, ε_2, and u are jointly normally distributed, with a covariance matrix that allows for nonzero correlation between the shocks to investment and the shocks to firms' characteristics.[6] The extent to which investment spending differs across the two regimes and the likelihood that firms are assigned to either regime are simultaneously determined. The approach yields separate regime-specific estimates for investment equations, dispensing with the need to use *ex-ante* regime sortings.

We note that in order to fully identify the switching regression model we need to determine which regime is the constrained one and which regime is the unconstrained. The algorithm specified in Eqs. (8)–(11) creates two groups of firms that differ according to their investment behavior, but it does not automatically tell the econometrician which firms are constrained. To achieve identification, we need to use our theoretical priors about which firm characteristics are associated with financial constraints. As we will see below, this assignment turns out to be unambiguous in our data.

One advantage of our approach is that it allows us to use multiple variables to predict whether firms are constrained or unconstrained in the selection equation (Eq. (10)). In contrast, the traditional method of splitting the sample according to *a priori* characteristics is typically implemented using one characteristic at a time. In particular, the estimation of the selection equation allows us to assess the statistical significance of a given factor assumed to proxy for financing constraints, while controlling for the information contained in other factors. Of course, one question is which variables

[6] The covariance matrix has the form $\Omega = \begin{bmatrix} \sigma_{11} & \sigma_{12} & \sigma_{1u} \\ \sigma_{21} & \sigma_{22} & \sigma_{2u} \\ \sigma_{u1} & \sigma_{u2} & 1 \end{bmatrix}$, where var$(u)$ is normalized to 1. See Maddala (1986), Hu and Schiantarelli (1998), and Hovakimian and Titman (2004) for additional details.

should be used in the selection vector Z. Here, we follow the existing literature but add to the set of variables included in Z the main driver of our credit multiplier story: asset tangibility.

The set of selection variables that we consider comes directly from Hovakimian and Titman (2004).[7] Those variables seem to naturally capture different ways in which financing frictions may be manifested. The set includes a firm's size (proxied by the natural logarithm of total assets) and a firm's age (proxied by the natural logarithm of the number of years the firm appears in the COMPUSTAT tapes since 1971). We label these variables *LogBookAssets* and *LogAge*, respectively. The other variables are constructed as follows. *DummyDivPayout* is a dummy variable that equals 1 if the firm has made any cash dividend payments in the year. *ShortTermDebt* is the ratio of short-term debt (item #34) to total assets. *LongTermDebt* is the ratio of long-term debt (item #9) to total assets. *GrowthOpportunities* is the ratio of market to book value of assets. *DummyBondRating* is a dummy variable that equals 1 if the firm has a bond rating assigned by Standard & Poors. *FinancialSlack* is the ratio of cash and liquid securities to lagged assets. Finally, we include *Tangibility* in this set (see definitions in Section 3.2.3). All these variables are entered in the selection equation in lagged form.[8]

The standard regression model (*ex-ante* constraint selection) The standard empirical approach uses *ex-ante* financial constraint sortings and least square regressions of investment equations, where estimations are performed separately for each constraint regime. We also use this approach in our tests of the multiplier effect, implementing the sortings schemes discussed in Almeida et al. (2004):

- Scheme #1: In every year over the 1985–2000 period we rank firms based on their payout ratio and assign to the financially constrained (unconstrained) group those firms in the bottom (top) three deciles of the annual payout distribution. We compute the payout ratio as the ratio of total distributions (dividends plus stock repurchases) to operating income. The intuition that financially constrained firms have significantly lower payout ratios follows from Fazzari et al. (1988).

- Scheme #2: In every year over the 1985–2000 period we rank firms based on their total assets and assign to the financially constrained (unconstrained) group those firms in the bottom (top) three deciles of the annual asset size distribution. This approach resembles Gilchrist and Himmelberg (1995) and Erickson and Whited (2000), among others.

- Scheme #3: In every year over the 1985–2000 period we retrieve data on bond ratings assigned by Standard & Poors and categorize those firms with debt outstanding but without a bond

[7] The set of variables used in Hu and Schiantarelli (1997) resembles that of Hovakimian and Titman, but is more parsimonious. The results we obtain with the use of this alternative set is omitted from the paper, but are similar to what we report below.

[8] In a previous version of the paper, we also used a second set of selection variables that closely resemble those used in the *ex-ante* selection model below. The results are virtually identical to those reported in Table 3 and are omitted for space considerations.

rating as financially constrained. Financially unconstrained firms are those whose bonds are rated. Similar approaches are used by, e.g., Kashyap et al. (1994), Gilchrist and Himmelberg (1995), and Cummins et al. (1999).

- Scheme #4: In every year over the 1985–2000 period we retrieve data on commercial paper ratings assigned by Standard & Poors and categorize those firms with debt outstanding but without a commercial paper rating as financially constrained. Financially unconstrained firms are those whose commercial papers are rated. This approach follows from the work of Calomiris et al. (1995) on the characteristics of commercial paper issuers.

3.2.3 Tangibility measures

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 the proceeds from discontinued operations reported by a sample of COMPUSTAT firms over the 1984–1993 period. The authors find that a dollar of book value yields, on average, 72 cents in exit value for total receivables, 55 cents for inventory, and 54 cents for fixed assets. Following their study, we estimate liquidation values for the firm-years in our sample via the computation:

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

where *Receivables* is COMPUSTAT item #2, *Inventory* is item #3, and *Capital* is item #8. As in 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 one of the next two measures of tangibility.

The second measure of tangibility we use is a time-variant, industry-level proxy that gauges the *ease* with which lenders can liquidate a firm's productive capital. Following Kessides (1990) and Worthington (1995), we measure asset redeployability 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 data are compiled by the Bureau once every five years. We match our COMPUSTAT data set 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.[9] Estimations based on this measure of tangibility use smaller sample sizes since not all of COMPUSTAT's SIC codes are covered by the Census and recent Census surveys omit the new/used capital purchase breakdown.

The third measure of tangibility we consider is related to the proxy just discussed in that it also gauges creditors' ability to readily dispose of a firm's assets. Based on the well-documented high cyclicality of durables goods industry sales, we use a durable/nondurable industry dichotomy that relates asset illiquidity to operations in the durables sector. This proxy is also in the spirit of Shleifer and Vishny (1992), who emphasize the decline in collateralized borrowing in circumstances in which assets in receivership will not be assigned to first-best alternative users: other firms in the same industry. 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 implementation follows the work of 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 label the remaining industries "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).

Tangibility of new versus existing assets One potential caveat is that, strictly speaking, Proposition 1 refers to variations in the tangibility of new investments. The three measures that we use, however, refer to the tangibility of assets in place. If the assets that are acquired with the new investment are of a similar nature to those that are already in place, then the distinction between tangibility of new and existing assets is unimportant for most practical purposes. In this case, our measures will be good proxies for the tangibility of new investment. We believe this is a reasonable assumption for a very large portion of observed capital expenditures in our data, specially given that we restrict our sample to manufacturing firms, and discard from our sample those firms that display large jumps in business fundamentals (size and sales). These data filters allow us to focus on firms whose demand for capital investment follow a more predictable/standard expansion path.

Unfortunately, data limitations preclude us from providing direct evidence for the conjecture that the tangibility of assets in place is a good proxy for the tangibility of new investment. In particular,

[9] E.g., we use the 1987 Census to gauge the asset redeployability of COMPUSTAT firms with fiscal years in the 1985–1989 window.

we don't have detailed information on the types of physical assets that are acquired with the marginal dollar of investment. We note, however, that if the tangibility of the existing assets is a poor proxy for the tangibility of marginal investments, then our tests should lack the power to identify the credit multiplier effect. Later in the analysis (Section 3.6), we go a step further and experiment with this idea to provide an indirect challenge to this scale-enhancing assumption.

3.2.4 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 impact of cash flows on investment spending. 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 (see Cummins et al. (1999), Erickson and Whited (2000), Gomes (2001), and Alti (2003)).

Fortunately, these problems do not have a first-order effect on the types of inferences about constrained investment that we can make with our tests. The argument in the literature (e.g., Gomes (2001) and Alti (2003)) is that Q can be a comparatively poorer proxy for investment opportunities for firms typically classified as financially constrained. This proxy quality problem can bias upwards the level of investment–cash flow sensitivities for firms seen as constrained even in the absence of financing frictions. Our proposed testing strategy sidesteps this problem because our empirical test is independent of the *level* of the estimated cash flow coefficients of constrained and unconstrained firms. In contrast, it revolves around the *marginal* effect of asset tangibility on the impact of income shocks on spending under credit constraints (the credit multiplier mechanism). In order to argue that a systematic relationship between tangibility and the bias afflicting the Q coefficient drives our results, 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.

However, cross-sample differences in measurement biases affecting Q are not the only source of problems for tests that rely on standard investment–cash flow sensitivities. In the context of the Fazzari et al. (1988) test, for example, Erickson and Whited (2000) have shown that cross-sample differences in the variance of cash flows alone may generate differences in cash flow sensitivities across constrained and unconstrained firms when Q is mismeasured. Since we use Q in our basic estimations, it is possible that similar statistical issues could bias the inferences that we make using the credit multiplier mechanism.[10] 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 potential indeterminacy,

[10] Taken literally, Erickson and Whited's arguments imply that *any* regression featuring Q may be subject to biases.

we also experiment with several techniques that produce reliable sensitivity estimates even when Q is mismeasured. First, we follow Cummins et al. (1999) and estimate our baseline model using a GMM estimator that uses financial analysts' earnings forecasts as instruments for Q. Second, we use the measurement error-consistent GMM estimator suggested by Erickson and Whited (2000). Finally, we estimate Bond and Meghir's (1994) Euler-based empirical model of capital investment; this estimator entirely dispenses with the need to include Q in the set of regressors.

3.3 Sample Characteristics

Our sample selection criteria and variable construction follow the standard in the financial constraints literature. The only exception concerns the central variable of our study: asset tangibility. To save space, our discussion about basic sample characteristics revolves around that variable. Table 1 reports detailed summary statistics for each of the three measures of asset tangibility we use. The first tangibility measure indicates that a firm's assets in liquidation are expected to fetch, on average, 53 cents on the dollar of book value. The second measure indicates that the average industry-level ratio of used to total (i.e., used plus new) capital acquisitions is 7.4%. The third indicates that 46.4% of the sample firms operate in the nondurable goods industries.

Table 1 about here

Table 2 reports summary statistics for firm investment, Q, and cash flows, separately for firms with high and low 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. Our first two measures of tangibility are continuous variables 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 a dichotomous variable and we categorize as low-tangibility (high-tangibility) firms those firms in durables (nondurables) industries. The numbers in Table 2 imply 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 2 about here

3.4 Results

We first report and interpret the results from the switching regression model. Then we describe the results we obtain when we use the standard estimation approach to investment spending across constrained and unconstrained firms.

3.4.1 Switching regressions

Table 3 presents the results returned from the switching regression estimation of our baseline model (Eqs. (8)–(10)). Panel A contains the results from the structural investment equations for constrained and unconstrained firms. In this panel, each of the three rows reports the results associated with a particular measure of asset tangibility. Panel B contains the results from the constraint selection equations. In this panel, each of the three columns corresponds to a particular measure of asset tangibility. In addition, the last row of panel B reports P-values for the test of the null hypothesis that a single investment regime — as opposed to two regimes (constrained *versus* unconstrained) — is sufficient to describe the data. This test is based on a likelihood ratio statistic for which the χ^2 distribution can be used for statistical inferences (cf. Goldfeld and Quandt (1976)).

A total of 6 investment equations (3 tangibility proxies $\times$ 2 constraints categories) are reported, yielding 3 constrained–unconstrained comparison pairs. Since we use interaction terms in all of our regressions and because the key variable used to gauge interaction effects (namely, *Tangibility*) is defined differently across our estimations, we carefully discuss the economic meaning of all of the estimates we report.

TABLE 3 ABOUT HERE

Firstly, consider the results from the selection equations (Panel B). As it turns out, the results we obtain are very similar to those of Table 4 in Hovakimian and Titman (we note that the outputs from the two papers have reversed signs by construction). As in their paper, we find that companies that are smaller, that are younger, that pay lower amounts of dividends, that have greater investment opportunities, that do not have bond ratings, and that carry greater financial slack are grouped together into one of the investment regimes (regime 1).[11] Our theoretical priors suggest that this is the group of firms that are most likely to be financially constrained. We also find that short- and long-term ratios have relatively little effect on the likelihood of being classified in either group. More important for our story, note that *Tangibility* leads to a lower probability of being in regime 1, that is, a lower probability of facing financial constraints — its implied effect is comparable to that of bond ratings.[12] And this result is statistically significant for each one of our tangibility proxies.

Panel A of Table 3 reports the central findings of this paper. Based on the results from the selection model, we call the firms classified in investment regime 1 (regime 2) "constrained" ("unconstrained") firms. Notice that *each and every one* of the regression pairs in the table reveals the same

[11] Note that the dependent variable in Panel B of Table 3 is a dummy that is equal to 1 if the firm is in investment regime 1, and 0 if the firm is in investment regime 2.

[12] For illustration, while holding other variables at their unconditional average values, a large (two standard deviation) increase in *Tangibility* brings down the probability of being financially constrained by about as much as the granting of a bond rating by S&P.

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. Indeed, the interaction between cash flow and tangibility attracts positive, statistically significant coefficients in all of the constrained firm estimations. Further, these coefficients are uniformly higher than those of the unconstrained samples, and statistically different at the 1% (alternatively, 5%) test level in all but one (alternatively, all) of the comparison pairs. Because higher tangibility makes it more likely that a firm will be unconstrained (Panel B), the positive effect of tangibility on investment–cash flow sensitivities is most likely to obtain for low levels of tangibility. These findings are fully consistent with the presence of a multiplier effect for constrained firm investment that works along the lines of our model.

It is important to illustrate the impact of asset tangibility on the sensitivity of investment to cash flows when the firm is financially constrained (the credit multiplier effect). To do so, we consider the estimates associated with our baseline measure of tangibility (first row of Panel A in Table 3). Notice that when calculated at the first quartile of *Tangibility* (i.e., at 0.32, see Table 1), the partial effect of a one-standard-deviation cash flow innovation (which is equal to 0.67) on investment per dollar of capital is approximately 0.09. In contrast, at the third quartile of the same measure (i.e., at 0.69), that partial effect exceeds 0.20.[13] To highlight the importance of these estimates we note that the mean investment-to-capital ratio in our sample is 0.24. Analogous calculations for unconstrained firms yield mostly economically and statistically insignificant effects regarding the effect of asset tangibility. Because we are not strictly estimating structural investment equations, these economic magnitudes should be interpreted with some caution. Yet, they clearly ascribe an important role for the credit multiplier in shaping the investment behavior of constrained firms.

Notice that the coefficients on *CashFlow* are negative in row 1 of the table, but positive in the estimations reported in rows 2 and 3. This sign reversal is due to the impact of the (tangibility-) "interaction" effect on the "main" regression effect of cash flows, coupled with the fact that *Tangibility* is a quite different regressor across the estimations in rows 1 through 3. Importantly, the estimates in row 1 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 1, is a point outside the empirical distribution of that firm-level measure of tangibility.[14] Indeed, when we compute the partial effect of cash flows on investment we find that these effects are positive

[13] The partial effects are equal to the standard deviation of cash flows times the coefficient on *CashFlow*, plus that same standard deviation times the coefficient on the interaction term times the level of *Tangibility* (first or third quartiles).

[14] The linear 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. The minimum observation in the distribution of our baseline measure of tangibility is 0.11.

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 (rows 2 and 3). In those estimations, *CashFlow* returns a positive significant coefficient, also consistent with the idea that cash flow and investment are positively correlated, even when tangibility is low.

The remaining estimates in Panel A of Table 3 display patterns that are also consistent with our story and with previous research. For instance, the coefficients returned for Q are in the same range of those reported by Gilchrist and Himmelberg (1995) and Polk and Sapienza (2004), among other comparable studies. Those coefficients tend to be somewhat 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 coefficients returned for *Tangibility* are positive in our estimations, although statistically insignificant.

3.4.2 Standard regressions

Table 4 presents the results returned from the estimation of our baseline regression model for *a priori* determined sample partitions and for each of our three tangibility proxies. Here, Eq. (7) is estimated via OLS with firm- and year-fixed effects,[15] 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.

TABLE 4 ABOUT HERE

As in our previous estimations, notice that each one of the regression pairs in the table show that constrained firms' investment–cash flow sensitivities are increasing in asset tangibility, while unconstrained firms' sensitivities show little or no response to tangibility. Once again, the interaction between cash flow and tangibility attracts positive, statistically significant coefficients in all of the constrained firm estimations. And these coefficients are uniformly higher than those of the unconstrained samples: constrained–unconstrained coefficient differences are significant at the 1% test level in 10 of the 12 pairs. The results we obtain through this estimation approach are also fully consistent with the presence of the credit multiplier effect our theory describes. They are of special interest in that they are very closely related to the types of tests implemented in the vast literature on financial constraints.

3.5 Robustness

We subject our findings to a number of robustness checks in order to address potential concerns with empirical biases in our estimations. These additional checks involve, among others, changes to our

[15] 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.

baseline specification (including the use of alternative lagging schemes), changes to proxy construction and instrumentation, subsampling checks, and outlier treatment (e.g., winsorizing at extreme quantiles). These tests produce no qualitative changes to our empirical findings and are omitted from the paper for space considerations. In contrast, we report here a number of less standard, more sophisticated checks of the reliability of our findings. These tests build on the traditional constraint classification approach, for which previous research has developed alternative procedures meant to verify estimation robustness. It is worth pointing out that checks of the types we describe below have been used to *dismiss* the inferences one achieves based on estimates of investment–cash flow sensitivities. We report the results from these checks in Table 5, where for conciseness, we only present the estimates returned for the interaction term $CashFlow \times Tangibility$ — this term captures our credit multiplier effect. For ease of exposition, we focus our discussion on the results associated with our baseline proxy for asset tangibility.

The primary concern we want to address is the issue of measurement errors in our proxy for investment opportunities, Q. We investigate the possibility that mismeasurement in Q may affect our inferences by using the estimators of three papers that tackle this empirical issue: Cummins et al. (1999), Erickson and Whited (2000), and Bond and Meghir (1994). Results from these GMM estimators (including the associated Hansen's J-statistics for overidentification restrictions) are reported in Table 5.

TABLE 5 ABOUT HERE

In the first row of Table 5, we follow the work of Cummins et al. (1999) and use financial analysts' forecasts of earnings as an instrument for Q in a GMM estimation of our investment model. As in Almeida et al. (2004), we employ the median forecast of the two-year ahead earnings scaled by lagged total assets to construct the earnings forecast measure. The set of instruments in these estimations also includes lags 2 through 4 of firm investment and cash flows. Although only some 80% of the firm-years in our original sample provide valid observations for earnings forecasts, our basic results remain.

The second row of Table 5 displays the interaction term coefficients we obtain from the estimator labeled GMM5 in Erickson and Whited (2000); this uses higher-order moment conditions for identification (as opposed to conditional mean restrictions).[16] One difficulty we find in implementing 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 of data after subjecting our sample to those authors' data "pre-tests," and these windows cover different stretches of our sample period. Moreover, the use of their procedure fails to return estimates for the constraint characterizations that are based on payout ratios and bond ratings.[17] In spite of these limitations, we find that our

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

[17] Erickson and Whited, too, report these sampling difficulties in their paper; their sample is constrained to a

previous inferences continue to hold for each of the remaining constraint criteria. These findings are reassuring in that they suggest that mismeasurement in empirical Q does not seem to translate into biased inferences about the credit multiplier effect of asset tangibility.

In row 3, we experiment with the Euler-type investment 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.

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

Our analysis has implicitly assumed that the tangibility of existing assets is a good proxy for the tangibility of marginal investments (see Section 3.2.3). In this section, we revisit our proxy assumption based on an indirect line of reasoning. To wit, we challenge our data assumptions and experiment with the idea that if the tangibility of the existing assets is a poor proxy for the tangibility of marginal investments, then our tests should lack the power to identify the credit multiplier effect.

To do so, we gather data on expenditures that do *not* obey the scale-enhancing restriction. R&D expenditures constitute a good example. Irrespective of the tangibility of the firm's assets, marginal R&D investments should be associated with very low tangibility (if any). Differently from capital expenditures, investments in intangible assets do not generate additional debt capacity, and thus should not yield a multiplier effect. Our theory would then suggest that we should *not* find a credit multiplier effect if we estimate the cash flow sensitivity of R&D expenditures. While confirming this conjecture is not a direct proof that our scale-enhancing hypothesis is correct for capital expenditures, it provides evidence that if our hypothesis was incorrect (i.e., that if we used very poor proxies for marginal tangibility) we would not have found the results that we report.

To specify a test that isolates the multiplier effect associated with R&D investments, we must address the following complication. 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 spending in R&D. Hence, it is not necessarily the case that the cash flow sensitivity of R&D investment

four-year window containing only 737 firms. Differently from their paper, our specification features 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 size and commercial paper ratings over the 1996–1998 and 1992–1994 periods, respectively.

is uncorrelated with tangibility in the data, even when R&D adds nothing to a firm's credit capacity.

This argument suggests that in order to isolate the R&D multiplier, we have to control for the level of endogenous capital expenditures in the R&D regression. Because the effect of (fixed capital) tangibility on R&D is transmitted through a variation in capital expenditures, the cash flow sensitivity of R&D expenditures should then be independent of asset tangibility. 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 of 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.

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 estimating the following model:

$$\begin{aligned} I_{R\&D i,t} &= \beta_1 \widehat{I}_{i,t} + \beta_2 CashFlow_{i,t} + \beta_3 Tangibility_{i,t} \\ &\quad + \beta_4 \left(CashFlow \times Tangibility\right)_{i,t} + \sum_i firm_i + \sum_t year_t + \varepsilon_{i,t.} \end{aligned} \tag{12}$$

Notice that we do not need to include proxies for investment opportunities in the set of regressors in Eq. (12), because the effect of investment opportunities is also subsumed in the relationship between $I_{R\&D}$ and $\widehat{I}$. This insight in turn allows us to use lagged Q to identify the model.[18] Our hypothesis is that the effect of cash flow on R&D investment is *independent* of tangibility, even for constrained firms.

Table 6 reports the results from the estimation of Eq. (12) via switching regressions. Each of the three rows in the table refers to one of our measures of tangibility, where we report the results for the structural equations across constrained and unconstrained sample, but omit the output from the selection equation. 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 agree with our conjecture that the use of poor proxies for marginal tangibility should lead to failure in uncovering the credit multiplier.

TABLE 6 ABOUT HERE

[18] 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.

4 Concluding Remarks

Despite the theoretical plausibility of a channel linking financing frictions and real investment, previous literature has found it difficult to empirically identify this channel. This paper proposes a novel identification scheme, which is based on the effect of asset pledgeability on financially constrained corporate investment. 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 empirical problems that have been associated with the traditional Fazzari et al.'s (1988) approach. Our methodology incorporates Kaplan and Zingales's (1997) suggestion that investment–cash flow sensitivities need not decrease monotonically with variables that relax financing constraints. However, we argue that this non-monotonicity can be used in a positive way, to help uncover information about financing constraints that might be embedded in investment–cash flow sensitivities. 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 other financial variables, and in more general contexts where investment–cash flow sensitivities might help in drawing inferences about the interplay between capital markets and corporate behavior.

The evidence we uncover in this paper is strongly consistent with a link between financing frictions and investment. As we hypothesize, we find that while asset tangibility increases investment–cash flow sensitivities for financially constrained firms, no such effects are observed for unconstrained firms. Moreover, tangibility influences a firm's credit status according to theoretical expectations: firms with more tangible assets are less likely to be financially constrained. The positive effect of tangibility on constrained cash flow sensitivities is evidence for a credit multiplier in U.S. corporate investment. Income shocks have especially large effects for constrained firms with tangible assets, because these firms have highly procyclical debt capacity. This insight can have interesting implications for asset pricing and macroeconomics, which could be explored by future researchers and policymakers.[19]

[19] See Hahn and Lee (2005) for recent evidence that the credit multiplier has implications for the cross-section of stock returns, Almeida et al. (2005), for evidence that the credit multiplier amplifies fluctuations in housing prices and housing credit demand, and Gan (2004), who examines the interaction between the credit multiplier and the collapse of Japanese land prices in the 1990's.

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Table 1: Summary Statistics for Asset Tangibility

This table displays summary statistics for asset tangibility. There are three measures of asset tangibility. The first is based on a firm-level proxy for expected value of assets in liquidation (as in Berger et al. (1996)) and the second on an industry-level measure of asset redeployability based on Census data. These two measures are continuous. The third tangibility measure is based on Sharpe's (1994) industry "durability," where a value of 1 is assigned to firms belonging to nondurable goods industries. The sampled firms include only manufacturers (SICs 2000–3999) and the sample period is 1985 through 2000.

	Mean	Median	Std. Dev.	Pct. 10	Pct. 25	Pct. 75	Pc.t 90	N
Asset Tangibility Measures								
1. Firm Liquidation Values	0.526	0.537	0.169	0.262	0.324	0.686	0.739	17,880
2. Industry Asset Liquidity	0.074	0.059	0.052	0.026	0.038	0.099	0.136	11,826
3. Industry Durability	0.464	0	0.499	0	0	1	1	18,304

Table 2: Summary Statistics of Investment, Q, and Cash Flow, across Low- and High-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 1985 through 2000.

	Investment			Q			*CashFlow*			N
	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.	
Asset Tangibility Measures										
1. Firm Liquidation Values										
Low-Tangibility Firms	0.219	0.210	0.148	0.997	0.960	0.429	0.319	0.306	0.667	5,364
High-Tangibility Firms	0.266	0.218	0.229	1.024	0.966	0.460	0.401	0.384	0.683	5,364
2. Industry Asset Liquidity										
Low-Tangibility Firms	0.241	0.185	0.208	1.032	0.922	0.371	0.331	0.264	0.547	3,547
High-Tangibility Firms	0.255	0.206	0.198	0.989	0.919	0.400	0.387	0.353	0.495	3,546
3. Industry Durability										
Low-Tangibility Firms	0.252	0.199	0.206	1.008	0.992	0.415	0.342	0.315	0.713	9,782
High-Tangibility Firms	0.216	0.183	0.155	0.988	0.928	0.381	0.323	0.290	0.494	8,522

Table 3: Investment–Cash Flow Sensitivity and Tangibility: Endogenous Constraint Selection (Baseline Switching Regression Model)

This table displays results from the investment regressions in the switching regression model (Eqs. (8)–(10) in the text). These equations are estimated with firm- and time-fixed effects. Switching regression estimations allow for endogenous selection into "financially constrained" and "financially unconstrained" categories via maximum likelihood methods. Panel B of Table 3 reports the coefficients from the "regime selection" regressions, where *Tangibility* (various definitions) and the selection variables employed in Hovakimian and Titman (2004) are used to assign firms into constraint categories. All data are from the annual COMPUSTAT industrial tapes. The sampled firms include only manufacturers (SICs 2000–3999) and the sample period is 1985 through 2000. The estimations correct the error structure for heteroskedasticity and clustering using the White-Huber estimator. *t*-statistics (in parentheses).

PANEL A: MAIN REGRESSIONS – FINANCIAL CONSTRAINTS ASSIGNMENTS USE TANGIBILITY AND THE PROXIES OF HOVAKIMIAN AND TITMAN (2004)

Dependent Variable		Independent Variables			N
Investment	*Q*	*CashFlow*	*Tangibility*	*CashFlow*× *Tangibility*	
ASSET TANGIBILITY MEASURES					
1. FIRM LIQUIDATION VALUES					
Constrained Firms	0.0819**	–0.0270**	0.0342	0.4898**	17,880
	(10.77)	(–2.26)	(1.44)	(8.99)	
Unconstrained Firms	0.0639**	0.0598*	0.0176	–0.0873	
	(2.64)	(2.27)	(0.62)	(–1.46)	
2. INDUSTRY ASSET LIQUIDITY					
Constrained Firms	0.0801**	0.0373**	0.0211	0.3923**	11,826
	(7.00)	(3.10)	(1.26)	(5.01)	
Unconstrained Firms	0.0648**	0.0905**	0.0668	0.0711	
	(4.06)	(4.14)	(0.80)	(0.82)	
3. INDUSTRY DURABILITY					
Constrained Firms	0.0561**	0.0849**	0.0133	0.0492**	18,304
	(5.44)	(3.09)	(1.09)	(2.88)	
Unconstrained Firms	0.0335**	0.1454**	0.0197	–0.0147	
	(3.25)	(8.65)	(1.52)	(–0.86)	

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

Table 3.: — Continued

For each of the estimations reported in this panel (one for each of three proxies for asset tangibility), the dependent variable is coded 1 for assignment into investment regime 1, and 0 for assignment into investment regime 2. As explained in the text, firms assigned into investment regime 1 are classified as financially constrained, and those assigned into investment regime 2 are classified as financially unconstrained. This classification is based on theoretical priors about which firm characteristics are likely to be associated with financial constraints. Each of the selection variables is entered in lagged form. *LogBookAssets* is the natural logarithm of total book assets (item #6). *LogAge* is the natural log of the number of years the firm appears in the COMPUSTAT tapes since 1971. *DummyDivPayout* is a dummy variable that equals 1 if the firm has made any cash dividend payments. *ShortTermDebt* is the ratio of short-term debt (item #34) to total assets. *LongTermDebt* is the ratio of long-term debt (item #9) to total assets. *GrowthOpportunities* is the ratio of market to book value of assets. *DummyBondRating* is a dummy variable that equals 1 is the firm has a bond rating assigned by Standard & Poors. *FinancialSlack* is the ratio of cash and liquid securities (item #1) to lagged assets. *Tangibility* is measured according to various firm- and industry-level measures (see text for details). The estimations correct the error structure for heteroskedasticity and clustering using the White-Huber estimator. t-statistics (in parentheses). The last row reports P-values for the test of the null hypothesis that a single investment regime is sufficient to describe the data.

Panel B: Endogenous Selection Regressions

	Asset Tangibility Measures		
	Firm Liq. Values	Industry Liquidity	Industry Durability
Regime Selection Variables			
LogBookAssets	–0.3248**	–0.2811**	–0.2271**
	(–8.97)	(–9.34)	(–10.98)
LogAge	–0.4097**	–0.3277**	–0.2355**
	(–10.96)	(–15.69)	(–8.24)
DummyDivPayout	–0.1833**	–0.2479**	–0.1976**
	(–7.48)	(–11.90)	(–10.50)
ShortTermDebt	0.0919	0.0293	0.0274
	(0.22)	(0.12)	(0.05)
LongTermDebt	0.1551	0.0924	0.0714
	(1.22)	(1.02)	(0.66)
GrowthOpportunities	0.2609**	0.2719**	0.2246**
	(9.30)	(8.82)	(8.01)
DummyBondRating	–0.1757**	–0.2066**	–0.1855**
	(–6.02)	(–8.09)	(–5.11)
FinancialSlack	0.2719**	0.2980**	0.2985**
	(8.42)	(9.32)	(7.42)
Tangibility	–0.0994**	–0.0766**	–0.1255**
	(–7.15)	(–6.98)	(–7.42)
Model P-value (Likelihood Ratio Test)	0.000	0.000	0.000

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

Table 4: Investment–Cash Flow Sensitivity and Tangibility: *Ex-ante* Constraint Selection (Standard Regressions)

This table displays OLS-FE (firm and year effects) estimation results of the augmented investment model (Eq. (7) in the text). The estimations use pre-determined firm selection into "financially constrained" and "financially unconstrained" categories. Constraint category assignments use on *ex-ante* criteria based on firm dividend payout, size, bond ratings, and commercial paper ratings (see text for details). All data are from the annual COMPUSTAT industrial tapes. The sampled firms include only manufacturers (SICs 2000–3999) and the sample period is 1985 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	0.0671**	–0.0715**	–0.0501	0.3451**	0.118	5,697
	(4.35)	(–5.55)	(–0.94)	(5.63)		
Unconstrained Firms	0.0380**	0.2042*	0.0273	–0.0439	0.149	5,327
	(2.72)	(2.35)	(0.40)	(–0.31)		
2. Firm Size						
Constrained Firms	0.0623**	–0.1066**	–0.1053	0.3985**	0.103	4,854
	(3.83)	(–5.46)	(–1.56)	(8.14)		
Unconstrained Firms	0.0543**	0.1901*	0.0996	–0.1652	0.114	5,300
	(3.71)	(2.43)	(1.32)	(–1.14)		
3. Bond Ratings						
Constrained Firms	0.0862**	–0.0926**	–0.1112	0.3260**	0.106	11,748
	(7.64)	(–5.97)	(–1.41)	(6.59)		
Unconstrained Firms	0.0402**	0.0623	–0.0177	0.0953	0.091	5,091
	(3.73)	(0.96)	(–0.35)	(0.87)		
4. Commercial Paper Ratings						
Constrained Firms	0.0841**	–0.0897**	–0.1215	0.3588**	0.099	14,194
	(8.51)	(–6.03)	(–1.78)	(7.06)		
Unconstrained Firms	0.0353*	0.0908*	0.0071	0.1177	0.138	2,645
	(2.51)	(2.02)	(0.12)	(1.42)		

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	0.0711**	0.0591**	–0.0359	0.5781**	0.078	3,387
	(4.05)	(2.70)	(–0.41)	(3.84)		
Unconstrained Firms	0.0565**	0.0934**	0.1276	–0.2328	0.142	3,117
	(3.37)	(5.58)	(1.21)	(–1.15)		
2. FIRM SIZE						
Constrained Firms	0.0820**	0.0881**	0.0633	0.2952*	0.100	3,104
	(4.30)	(3.75)	(0.62)	(2.28)		
Unconstrained Firms	0.0753**	0.0725**	–0.0820	–0.3448	0.114	3,117
	(4.42)	(3.40)	(–0.56)	(–1.08)		
3. BOND RATINGS						
Constrained Firms	0.0914**	0.0660*	–0.0083	0.5048**	0.117	6,889
	(7.09)	(2.36)	(–0.08)	(2.94)		
Unconstrained Firms	0.0576**	0.1078**	–0.0799	0.0607	0.092	3,169
	(4.03)	(3.00)	(–0.75)	(0.28)		
4. COMMERCIAL PAPER RATINGS						
Constrained Firms	0.0900**	0.0682**	–0.0127	0.4631**	0.109	8,471
	(7.71)	(2.88)	(–0.14)	(3.23)		
Unconstrained Firms	0.0313**	0.1552**	–0.1371	0.0454	0.143	1,587
	(3.22)	(6.19)	(–0.85)	(0.21)		

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	0.0738**	0.0501**	–0.0290	0.0552**	0.095	6,443
	(7.53)	(3.62)	(–1.73)	(2.97)		
Unconstrained Firms	0.0220	0.1602**	0.0050	–0.0388	0.233	5,497
	(1.59)	(8.80)	(0.52)	(–1.54)		
2. FIRM SIZE						
Constrained Firms	0.0537**	0.1208**	–0.0150	0.0668**	0.099	5,497
	(4.15)	(5.80)	(–1.45)	(3.27)		
Unconstrained Firms	0.0546**	0.0740**	–0.0111	–0.0575*	0.249	5,497
	(4.28)	(3.40)	(–0.90)	(–2.37)		
3. BOND RATINGS						
Constrained Firms	0.1051**	0.0737**	–0.0403*	0.0491*	0.088	13,213
	(8.51)	(4.91)	(–2.43)	(2.14)		
Unconstrained Firms	0.0314**	0.1326**	–0.0127	–0.0281	0.185	5,091
	(3.12)	(6.10)	(–1.40)	(–0.95)		
4. COMMERCIAL PAPER RATINGS						
Constrained Firms	0.0958**	0.0851**	–0.0446**	0.0573**	0.095	15,659
	(8.58)	(6.49)	(–2.36)	(3.03)		
Unconstrained Firms	0.0151	0.1333**	–0.0020	–0.0394*	0.226	2,645
	(1.35)	(6.01)	(–0.14)	(–2.20)		

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, Q, from 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. The estimations use pre-determined firm selection into "financially constrained" and "financially unconstrained" categories. $Tangibility$ is the firm-level proxy for asset liquidation values (based on Berger et al. (1996)). The first set of estimations (row 1) follows Cummins et al.'s (1999) GMM procedure where Q is instrumented with analysts' earnings forecasts. The second set of estimations (row 2) uses the Erickson–Whited (2000) GMM5 estimator. The estimations of row 3 are 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 1985 through 2000. The estimations correct the error structure for heteroskedasticity and clustering. t-statistics (in parentheses). Hansen's J-statistics for overidentifying restrictions tests [in square brackets].

Dependent Variable	Financial Constraints Criteria			
Investment	Payout Policy	Firm Size	Bond Ratings	CP Ratings
1. Cummins et al. Estimator				
Constrained Firms	0.2976** (3.19) [0.26]	0.4420** (5.78) [0.22]	0.2474** (2.99) [0.26]	0.2174** (2.63) [0.29]
Unconstrained Firms	−0.0752 (−0.46) [0.52]	−0.2413 (−1.51) [0.55]	–0.0470 (–0.36) [0.17]	0.0035 (0.67) [0.27]
2. Erickson–Whited Estimator				
Constrained Firms	N/A	0.4710** (2.91) [028]	N/A	0.2490** (2.66) [0.17]
Unconstrained Firms	N/A	–0.1230 (–0.51) [0.19]	N/A	–0.0240 (–0.08) [0.32]
3. Bond–Meghir Estimator				
Constrained Firms	0.3123** (2.83) [0.24]	0.5109** (3.69) [0.18]	0.3566** (3.77) [0.39]	0.3243** (4.10) [0.16]
Unconstrained Firms	0.0111 (0.43) [0.31]	0.0164 (0.45) [0.18]	0.0554 (0.86) [0.19]	−0.0477 (−0.76) [0.25]

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

Table 6: Fixed Capital and R&D Expenditures

This table displays results from the R&D expenditures model (Eq. (12)), where *Investment* is instrumented ($\widehat{I}$). Switching regression estimations allow for endogenous selection into "financially constrained" and "financially unconstrained" categories via maximum likelihood methods. The table reports only the coefficients from the "main" investment regressions. The "regime selection" regressions use *Tangibility* (various definitions) and the selection variables employed in Hovakimian and Titman (2004) to assign firms into constraint categories. All data are from the annual COMPUSTAT industrial tapes. The sampled firms include only manufacturers (SICs 2000–3999) and the sample period is 1985 through 2000. The estimations correct the error structure for heteroskedasticity and clustering using the White-Huber estimator. t-statistics (in parentheses).

Main Regressions – Financial constraints assignments use tangibility and the proxies of Hovakimian and Titman (2004)

Dependent Variable	Independent Variables				N
R&D Expenditures	$\widehat{I}$	*CashFlow*	*Tangibility*	*CashFlow*× *Tangibility*	
Asset Tangibility Measures					
1. Firm Liquidation Values					
Constrained Firms	0.5298**	0.0605*	–0.0019	–0.0816	15,077
	(2.58)	(2.25)	(–0.60)	(–1.36)	
Unconstrained Firms	0.3848*	0.1699**	–0.0673	–0.0623	
	(2.09)	(4.27)	(–1.52)	(–1.10)	
2. Industry Asset Liquidity					
Constrained Firms	0.6673**	0.0557*	0.0296	–0.0969	10,678
	(3.35)	(2.00)	(1.29)	(–1.29)	
Unconstrained Firms	0.3249*	0.1300**	0.0275	–0.1169	
	(2.08)	(3.27)	(1.20)	(–1.45)	
3. Industry Durability					
Constrained Firms	0.6897**	0.0444	–0.0094	–0.0265	16,527
	(3.77)	(1.75)	(–0.66)	(–1.83)	
Unconstrained Firms	0.5614**	0.0697*	0.0257	–0.0078	
	(2.66)	(2.22)	(1.14)	(–0.61)	

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