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WHEN DOES THE MARKET MATTER?
STOCK PRICES AND THE INVESTMENT OF EQUITY-DEPENDENT FIRMS

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ABSTRACT

We use a simple model of corporate investment to determine when investment will be sensitive to non-fundamental movements in stock prices. The key cross-sectional prediction of the model is that stock prices will have a stronger impact on the investment of firms that are "equity dependent" - firms that need external equity to finance their marginal investments. Using an index of equity dependence based on the work of Kaplan and Zingales (1997), we find strong support for this prediction. In particular, firms that rank in the top quintile of the KZ index have investment that is almost three times as sensitive to stock prices as firms in the bottom quintile. We also verify several other predictions of the model.

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I. Introduction

Corporate investment and the stock market are positively correlated, both in the time series and in the cross-section. The traditional explanation for this relationship is that stock prices rationally reflect the marginal product of capital. This is the usual interpretation given to the relationship between investment and Tobin's *Q*, for example, as in Tobin (1969) and von Furstenberg (1977).

Keynes (1936) suggests a very different explanation. He argues that stock prices contain an important element of irrationality. As a result, the effective cost of external equity sometimes diverges from the cost of other forms of capital. This affects the pattern of equity issues and in turn corporate investment. This "equity financing channel" has been developed in work by Bosworth (1975), Fischer and Merton (1984), Morck, Shleifer and Vishny (1990), Blanchard, Rhee and Summers (1993) and Stein (1996).

It has proven difficult to determine the relative merits of these explanations. This is partly because the equity financing channel has not been articulated in a form that can be empirically distinguished from the traditional view. Empirical tests have had to focus on indirect implications of the two views, or else have had to impose structural assumptions on the data. For example, researchers taking the former approach have examined whether the stock market forecasts investment over and above other measures of the marginal product of capital, such as profitability or cash flow. If it does not, they argue, then the stock market is probably connected to investment only insofar as it reflects fundamentals.

This empirical strategy has yielded mixed results. Barro (1990, p. 130) attributes an important independent role to the stock market: "Even in the presence of cash flow variables, such as contemporaneous and lagged values of after-tax corporate profits, the stock market variable retains significant predictive power for investment." In contrast, Morck, Shleifer and Vishny (1990, p. 199) conclude from their analysis of firm-level data that "the market may not be a complete sideshow, but nor is it very central." And Blanchard, Rhee and Summers (1993, p. 132) summarize their study of the aggregate data by stating that "market valuation appears to play a limited role, given fundamentals, in the determination of investment decisions."

Another empirical strategy is to try to measure inefficiency directly as the difference between market prices and a structural model of efficient prices, and then test whether investment is sensitive to this measure of inefficiency. In a study of aggregate Japanese data, Chirinko and Schaller (2001) find evidence for an equity financing channel using this approach. As they point out, however, their conclusions depend on several structural assumptions.

In this paper we take a new approach. We return to the theory to derive several cross-sectional predictions that are unique to a specific equity financing channel. In particular, the model in Stein (1996) implies that *firms that are in need of external equity finance will have investment that is especially sensitive to the non-fundamental component of stock prices.* Intuitively, a firm with no debt and a stockpile of cash can insulate its investment decisions from irrational gyrations in its stock price. But an "equity-dependent" firm that needs equity to fund its marginal investments will be less likely to proceed if it has to issue undervalued shares. The theory thus identifies a specific equity financing channel that suggests *when* the market matters in the cross-section and, at the same time, *why* it matters.

We test several implications of this financing channel. To get started, we need a proxy for the concept of equity dependence. This concept requires some financing friction, or combination of frictions, which makes certain firms more reliant on outside equity at the margin. Standard corporate-finance considerations suggest that equity-dependent firms will tend to be young, and to have high leverage, low cash balances and cash flows, high cash flow volatility (and hence low incremental debt capacity) and strong investment opportunities.[1] One off-the-shelf measure which satisfies most of these criteria is an index based on the work of Kaplan and Zingales (1997). This "KZ index" has already been adapted for use in large-sample empirical work by Lamont, Polk and Saa-Requejo (2001), so we can follow their methodology. By taking this approach, as opposed to building our own measure of equity dependence from scratch, we hope to minimize any concerns about data mining.

Next, we rank firms according to this proxy for equity dependence, and test in a variety of ways whether those that are classified as most likely to be equity dependent have the strongest correlation between stock prices and subsequent investment. We find strong support for this prediction. In our baseline specification, firms that rank in the top quintile of the sample in terms of the KZ index have a sensitivity of investment to stock prices that is almost three times as large as firms that rank in the bottom quintile.[2] Put differently, our results suggest that the investment of equity-dependent firms is in some circumstances more sensitive to *Q* than to cash flow. This is noteworthy because it is generally believed that the cash flow effect uniformly dominates the *Q* effect in investment equations.

We also examine whether these results for investment reflect the specific equity financing mechanism outlined in the model. This involves a test of whether the firms who are the most likely to be equity dependent also have the strongest correlation between stock prices and the

[1] Morck, Shleifer and Vishny (1990) look for a financing channel using firm size as their only proxy for equity dependence. They argue that the "hypothesis predicts that the influence of the stock market should be particularly great for smaller firms, which rely to a greater extent on external financing" (p. 182). However, they find little evidence that the investment of smaller firms is especially sensitive to stock prices, and conclude that there is little support for the hypothesis. As we show, the use of a more fully developed measure of equity dependence leads to quite different conclusions.

[2] The result that investment is more sensitive to *Q* for high-KZ firms actually shows up in Kaplan and Zingales' (1997) small 49-firm sample. However, their focus is on a different question – how investment-cash flow sensitivities vary with financial constraints – and they never discuss or interpret this particular finding.

volume of new equity issues. We find support for this hypothesis as well: Firms with high values of the KZ index also have equity issuance behavior that is more responsive to stock prices than their low-KZ counterparts.

Our results offer support for a specific equity financing channel in corporate investment. They also complement other evidence that the cost of external equity has an important, independent effect on corporate financing and investment decisions. For example, Ritter (1991), Ikenberry, Lakonishok, and Vermaelen (1995), Loughran and Ritter (1995), Speiss and Affleck-Graves (1995), and Baker and Wurgler (2000) find evidence that equity financing patterns depend on the cost of equity, and Baker and Wurgler (2002) use these results to motivate an alternative view of capital structure. Shleifer and Vishny (2001) argue that the cost of equity is a strong determinant of merger activity, explaining the form of financing in mergers as well as merger waves themselves. Whereas the capital structure findings could be viewed as financial phenomena without significant real effects, however, our results point to a specific channel through which market inefficiency may affect the real economy.

The remainder of the paper is organized as follows. In Section II, we develop several testable hypotheses in the context of a simple model. The model provides some guidance as to how to measure equity dependence in practice, and provides a framework for thinking about competing hypotheses. In Section III, we describe the data, and in Section IV, we present the empirical results. Section V concludes.

II. Hypothesis development

A. A simple model

We use a simplified version of the model in Stein (1996) to develop several testable hypotheses about equity dependence and investment. For starters, consider a firm that can invest K at time 0, which yields a gross return of $f(K)$ at time 1, where $f(\cdot)$ is an increasing, concave function. The efficient-market discount rate is r, so the net present value of this investment is $\frac{f(K)}{1+r} - K$. The first-best level of investment K^{fb} is therefore given by $\frac{f'(K^{fb})}{1+r} = 1$.

The firm also has financing considerations. Its equity may be mispriced by a percentage δ relative to the efficient-market value, either overpriced ($\delta > 0$) or underpriced ($\delta < 0$), while its debt is fairly priced.[3] The firm can issue equity e subject to the constraints that $0 \le e \le e^{\max}$. In other words, it cannot repurchase equity, and there is an upper bound on how much it can issue. Financing and investment are linked by a leverage constraint, $e + W - K(1-\overline{D}) \ge 0$, where W is the firm's pre-existing wealth (such as cash on hand, or untapped debt capacity) and $\overline{D}$ is the fractional debt capacity of the new assets. This constraint implies that the firm's debt ratio can fall below $\overline{D}$ but cannot exceed it.[4]

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[3] The model interprets δ as an irrational variation in the cost of external equity, but one could also view it as a rational gap between the cost of external and internal equity that reflects adverse-selection problems (Myers and Majluf (1984)). Moreover, some authors have argued that adverse-selection problems are mitigated in good times, which are generally associated with high stock prices (Lucas and McDonald (1990), Choe, Masulis and Nanda (1993), Bayless and Chaplinsky (1996)). Such an interpretation of δ can lead to similar empirical predictions. Our own view is that the first story – based on market inefficiencies – is a more compelling way of thinking about the connection between equity issues and stock prices, and more consistent with the evidence from surveys and long-run stock returns following equity issues. However, we note that none of our tests seek to discriminate between these stories. In fact, both of them are based on the same idea: managers try to time the market by selling stock when they think it is overvalued, and by sitting out when they think it is undervalued. The only difference is whether investors fully account for this motive.

[4] These constraints simplify the exposition, but they can be dispensed with in a fuller model. For example, both repurchases and equity issues could be bounded endogenously by assuming that there are price-pressure effects that increase with the size of the repurchase or issue. The simple form of the leverage constraint can also be generalized by having costs of financial distress that increase continuously whenever the debt ratio exceeds $\overline{D}$. These generalizations are considered in Stein (1996).

Putting all this together, the firm's optimization problem is given by:

$$\max_{e,K} \frac{f(K)}{1+r} - K + \delta e, \tag{1}$$

subject to

$$e + W - K(1-\overline{D}) \geq 0 \text{ and} \tag{2}$$

$$0 \leq e \leq e^{\max}. \tag{3}$$

Proposition 1 summarizes the solution to this problem.

Proposition 1: Assume that $e^{\max} > K^{fb}(1-\overline{D})$. Then the possible outcomes are as follows:

i) If $\delta > 0$, then $K = K^{fb}$ and $e = e^{\max}$: An overvalued firm invests at the first-best level and issues as much equity as possible.

ii) If $\delta < 0$ and $W - K^{fb}(1-\overline{D}) \geq 0$, then $K = K^{fb}$ and $e = 0$: An undervalued firm with sufficient wealth W invests at the first-best level and avoids issuing equity.

iii) If $\delta < 0$ and $W - K^{fb}(1-\overline{D}) < 0$, then $K < K^{fb}$: An undervalued firm with insufficient wealth underinvests. This case admits two subcases.

a) Define K^{ec} by $\frac{f'(K^{ec})}{1+r} = 1 - \delta(1-\overline{D})$. If $W - K^{ec}(1-\overline{D}) < 0$, it follows that $K = K^{ec}$ and $e = K^{ec}(1-\overline{D}) - W > 0$: The firm issues equity, and both investment and the size of the equity issue are functions of the degree of undervaluation δ and debt capacity $\overline{D}$.

b) If $W - K^{ec}(1-\overline{D}) \geq 0$, then $K = \frac{W}{1-\overline{D}}$ and $e = 0$: The firm does not issue equity and invests as much as it can subject to its wealth W and the leverage constraint.

The proposition makes clear when investment depends on the non-fundamental component of stock prices. This happens only when two necessary conditions are satisfied: when the stock is undervalued, and when available wealth is so low that the firm would have to issue undervalued equity to invest at the first-best level.[5] We therefore define a firm as "equity dependent" if $W < K^{fb}(1-\overline{D})$. The basic message of Proposition 1 is that for equity-dependent firms, market inefficiency can act like a financial constraint, discouraging investment when stock prices are too low.

B. Testable hypotheses

We boil Proposition 1 down to three empirical hypotheses. In each case, the null hypothesis is the joint statement that stock prices reflect the net present value of investment and that financing is frictionless – i.e., the benchmark Tobin's Q mechanism. The hypotheses that follow from the proposition, by contrast, maintain that stock prices have a non-fundamental component and that debt capacity can be a constraint.

Hypothesis 1: Define a firm as equity dependent if $W < K^{fb}(1-\overline{D})$. Equity-dependent firms display a higher sensitivity of investment to stock price than non-equity-dependent firms.

Hypothesis 1 is the primary focus of our empirical tests. As we state it, the hypothesis is not conditioned on whether firms are over- or undervalued. It effectively averages over region (i), where $\delta > 0$, and where equity dependence does not affect investment, and regions (ii) and (iii), where $\delta < 0$, and where equity dependence does matter for investment. Observe also that

[5] The conclusion that investment is sensitive to stock prices only when $\delta < 0$ is a result of the one-sided nature of the leverage constraint. One could also impose the constraint that an equity issue not cause leverage to fall *below* some critical value, in which case investment may vary with stock prices even when $\delta > 0$. The model of Shleifer and Vishny (2001) implicitly embodies such a feature—they assume that overvalued firms wishing to issue equity cannot simply park the proceeds in T-bills, and must do something concrete, like acquiring another firm, to justify the issue. Hence overvaluation leads to more investment in the form of mergers.

for the undervalued, equity-dependent firms in (iii.a), the magnitude of the sensitivity of investment to δ is governed by $(1-\overline{D})$, so that for a given starting value of K, firms with less debt capacity have investment that reacts more strongly to stock prices. The intuition is simple. When a firm has little wealth relative to its investment opportunities, it is forced to issue undervalued equity at the margin to keep the leverage constraint satisfied. This tends to discourage investment. And the lower is $\overline{D}$, the more equity must be issued for each marginal dollar of investment, hence the stronger is the negative effect on investment.

Proposition 1 also suggests various hypotheses that condition on δ – which we outline next – but the unconditional statement in Hypothesis 1 is more straightforward to test empirically, so we make it the focus of our empirical efforts.

Hypothesis 2*:* When $\delta < 0$, Hypothesis 1 holds more strongly: Equity-dependent firms display a particularly high sensitivity of investment to stock price when $\delta < 0$.

Hypothesis 2 compares the undervalued, non-equity-dependent firms in (ii) to the undervalued, equity-dependent firms in (iii), especially (iii.a). It is a more direct implication of the idea that equity dependence matters for investment only when equity is undervalued – in the model, when equity is overvalued, all firms invest at the first-best level regardless of the degree of overvaluation. Therefore, conditioning on undervaluation should reveal a stronger effect of equity dependence.

Hypothesis 2 is trickier to test than Hypothesis 1, however, because it requires us to proxy for the absolute level of over or undervaluation. This is further complicated by the fact that what really matters are managers' *perceptions* of misvaluation. A variety of evidence suggests that managers are not particularly objective when it comes to assessing whether their firms are fairly valued; indeed, they tend to be biased toward the view that their firms are chronically undervalued.[6] Thus, while we take a stab at testing Hypothesis 2, we view it more in terms of an auxiliary test of the model.

Hypothesis 3: When $\delta < 0$, equity-dependent firms display a higher sensitivity of equity issuance to stock price than non-equity dependent firms.[7]

Hypothesis 3 reflects the fact that in region (iii.a), the investment and equity issues of equity-dependent firms are tied together by the binding leverage constraint, and so both are sensitive to undervaluation. In contrast, the non-equity-dependent firms in region (ii) avoid issuing equity regardless of the degree of undervaluation. If this hypothesis can be confirmed in the data, it will provide additional evidence that our specific equity financing channel is driving any patterns in investment. Unfortunately, testing this hypothesis again requires a proxy for undervaluation, so again we view the results as somewhat provisional.

Note that our hypotheses involve simple comparisons between firms that are equity dependent and those that are not – that is, comparisons *across* the regions in Proposition 1. We can also ask what happens *within* region (iii.a) as firms become "more" equity dependent, i.e. as W falls further and further below $K^{fb}(1-\overline{D})$. The answer to this question depends on the form of the production function. Define the "degree" of equity dependence as $\Phi = K^{fb}(1-\overline{D}) - W$, and the

[6] Heaton's (1998) model is built on just this sort of managerial overconfidence.

[7] Note that, unlike in Hypothesis 2, we cannot predict that the relationship between equity issues and stock prices will be *stronger* in the undervaluation region than in the overvaluation region. Unlike with investment, the model (or a reasonable variant on it) allows for equity issues to be sensitive to stock prices even when they are overvalued.

percentage sensitivity of investment to stock prices as $S = \frac{1}{K} \cdot \frac{dK}{d\delta}$. (This measure of the sensitivity matches our empirical implementation, where we scale investment by existing assets.) It is straightforward to show that a sufficient condition for $\frac{dS}{d\Phi}$ to be positive in region (iii.a) – and hence for the sensitivity S to become ever greater as W declines relative to $K^{fb}(1-\overline{D})$ – is that $Kf'''(K) + f''(K) < 0$.[8]

When this condition is satisfied, there is a globally monotonic relationship between Φ and the sensitivity of investment and equity issuance to the non-fundamental component of stock prices. When it is not satisfied, we are left with the weaker prediction that S must increase as Φ moves from negative to positive values, but need not be monotonic in Φ beyond that point. To be clear, our three hypotheses are based on this weaker prediction. This situation is reminiscent of the discussion by Kaplan and Zingales (1997, 2000) and Fazzari, Hubbard, and Petersen (2000) as to whether the sensitivity of investment to cash flow is monotonic in the degree of a different kind of financial constraint. Nevertheless, even if the sufficient condition is not satisfied, the hypotheses show that the theory is testable as long as we can plausibly identify some firms that are not dependent on equity at all – i.e., firms for which $\Phi < 0$ – since the theory unambiguously predicts that the sensitivity of investment and equity issuance to stock prices will rise over at least this first part of the range of measured equity dependence. Whether these sensitivities continue to increase over the whole range is an empirical question, however, and not one for which the theory leaves us with strong priors.

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[8] Among the functions that satisfy this condition are the quadratic, and anything of the form $f(K) = K/(K+A)$, where $A > 2K$. Note that in our setup, S depends on Φ within region (iii.a) only through $\overline{D}$ and not through W, since dK/dW is zero in this region. Nevertheless, the sufficient condition stated in the text continues to apply even in a modified version of the model where $dK/dW > 0$ in the region of interest.

C. Determining equity dependence in practice

Our theory defines an equity-dependent firm as one in which $W < K^{fb}(1-\overline{D})$. This definition indicates that a firm is more likely to be dependent on equity when W is low (which translates into low profitability, cash balances, or previously untapped debt capacity), when K^{fb} is high (growth opportunities are good), and when the incremental debt capacity of new assets $\overline{D}$ is low.[9] Therefore, a sensible empirical measure of equity dependence should probably be: negatively related to operating cash flow; positively related to proxies for growth opportunities; positively related to actual leverage, net of cash on hand; and negatively related to the debt capacity of assets. Firm age may also be a factor, to the extent that young firms without established reputations may have a harder time raising bond-market finance (Diamond (1991)).

These observations motivate our interest in the empirical work of Kaplan and Zingales (1997), who do an in-depth study of the financial constraints faced by a sample of 49 manufacturing firms. Using both subjective and objective criteria, they rank these firms on an ordinal scale, from least- to most-obviously financially constrained. Most useful for our purposes, they then estimate an ordered logit regression which relates their ranking to five simple Compustat variables. The regression attaches positive weight to Q and leverage, and negative weight to operating cash flow, cash balances, and dividends. Thus, the parameters of this regression allow one to easily create a synthetic "KZ index" of financial constraints for a large sample of firms, as is done in Lamont, Polk and Saa-Requejo (2001).

The KZ index has some very attractive features from our perspective. It is an objective, off-the-shelf index that has already gained substantial currency as an indicator of financial constraints. By using it, as opposed to building our own measure from scratch, we hope to avoid

[9] These first two factors closely parallel the notion of "financial dependence" in Rajan and Zingales (1998).

any criticism of data mining. Moreover, relative to what is suggested by our theory, the KZ index seems at first glance to load up on each of the five included variables in the "right" way.

The index also has some disadvantages as a measure of equity dependence, however. Most importantly, our theoretical definition of equity dependence requires a measure of investment opportunities K^{fb} that is distinct from mispricing δ. Of the five variables in the KZ index, both low dividends and high values of Q can be thought of as proxies for strong investment opportunities. But in the case of Q, much research has argued that this ratio (effectively, the market-to-book ratio) reflects mispricing δ as much as it reflects investment opportunities K^{fb}. This dual role is particularly problematic from our perspective, since our model has opposite predictions for the effects of K^{fb} and δ.

In light of this ambiguity, our baseline specifications use a modified four-variable version of the KZ index that omits Q. We stress here, though, that we do this more for conceptual cleanness than because it has any real effect on the empirical results. As we demonstrate in our robustness tests, we obtain very similar estimates if we work instead with the five-variable version of the KZ index that includes Q.

Another disadvantage of the KZ index is that it does not include every characteristic that could identify equity dependence. Firm age is a noteworthy omission. And given the important role that available debt capacity plays in our model, we would have preferred to include leverage *relative* to the firm's debt capacity, not simply the raw debt level. In some of our auxiliary tests, we supplement the KZ index with two more variables, firm age and the volatility of industry cash flow (a proxy for debt capacity), in an effort to further zero in on equity-dependent firms.

The definitional shortcomings partly stem from the fact that Kaplan and Zingales (1997) set out to measure financial constraints generally, not equity dependence. Though related, these concepts are not exactly the same. For example, one can imagine a high-KZ firm whose investment is sensitive to debt-market conditions, but that would not issue equity at any price. An important part of our empirical work is therefore to confirm that high-KZ firms actually do raise significantly more outside equity when stock prices go up.

D. Competing hypotheses

Our null hypothesis throughout the empirical section is that the stock market is efficient and that financing is frictionless. This leads to the benchmark Q specification, in which the coefficient of investment on Q reflects technological adjustment costs.[10] The full statement of our null hypothesis is therefore that any cross-sectional differences in the sensitivity of investment to Q reflect cross-sectional differences in technological adjustment costs. This theory is silent about the sensitivity of equity issuance to Q.

Another competing hypothesis is that any patterns we may find in the investment-Q sensitivity are due to cross-sectional differences in measurement error. In particular, the effects predicted by our model would also show up if measurement error were more pronounced for firms that are less equity dependent. However, an important point to note is that such a pattern with respect to measurement error is precisely the *reverse* of that which has for many years been discussed in the large literature on liquidity constraints. For example, in his discussion of Fazzari, Hubbard, and Petersen (1988), Poterba (1988) argues that their results "could be explained on this view because Q is measured with more error for smaller firms, which tend to be lower-dividend firms" (p. 202). Erickson and Whited (2000) and Alti (2001) further develop this point; the latter builds a formal model to show why measurement error in Q is likely to be

[10] This model is treated in surveys of the investment literature by Chirinko (1993) and Hubbard (1998).

greater for young, faster-growing, low-dividend firms. Clearly, if these arguments are correct, our approach stands on safe ground. The KZ index scores low-dividend, high-growth firms as more likely to be equity dependent. If these attributes lead to more measurement error in *Q*, our tests will be biased toward being excessively conservative.

Nevertheless, it is possible to concoct measurement-error stories that go in the opposite direction. One way to partially address such stories, as well as the adjustment-costs null hypothesis, is by "unpacking" the KZ index. The definition of equity dependence leads to specific predictions for how *each* of the four components of the modified KZ index should affect the sensitivity of investment to stock prices. If these predictions hold up in the data, advocates of the competing hypotheses would then have to explain why technological adjustment costs, or measurement error in *Q*, should be positively correlated with some of these variables and negatively correlated with others. Our further tests that look at how the sensitivity of investment to stock prices varies with firm age and debt capacity can be thought of in a similar spirit.

III. Data

We study a large, unbalanced panel of Compustat firms that covers 1980 through 1999. The panel excludes financial firms (i.e., firms with a one-digit SIC of six), and firm-years with a book value under $10 million, but otherwise includes all observations with data on investment, financing, equity dependence, and other investment determinants, as described below. The full sample includes 51,982 observations, for an average of 2,599 observations per year.

A. Investment

We consider four measures of investment. Our baseline measure is $CAPX_{it}/A_{it-1}$, the ratio of capital expenditures in year *t* (Compustat Annual Item 128) to start-of-year book assets (Item 6).[11] In addition, we look at $(CAPX_{it}+RD_{it})/A_{it-1}$, which includes research and development expenses (Item 46), and at $(CAPX_{it}+RD_{it}+SGA_{it})/A_{it-1}$, which further includes selling, general and administrative expenses (Item 189). Finally, we also examine the percentage change in book assets over the year, $\Delta A_{it}/A_{it-1}$. To reduce the influence of outliers, we Winsorize each of these variables at the 1st and 99th percentile.[12]

Panel A of Table 1 shows summary statistics for investment. The reported minimum and maximum values, like the other statistics, are post-Winsorization.

B. Financing

We consider two measures of external financing activity. To measure equity issuance we use e_{it}/A_{it-1}, the ratio of external equity issues to start-of-year book assets. External equity issues are constructed as the change in book equity minus the change in retained earnings (ΔItem 60+ΔItem 74-ΔItem 36). Total external finance is measured as $(e_{it}+d_{it})/A_{it-1}$, which includes both equity and debt issues. Debt issues are constructed as the total change in assets minus the change

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[11] We scale our measures of investment and cash flow by book assets. This contrasts with some of the literature (e.g. Fazarri, Hubbard, and Petersen (1988) and Kaplan and Zingales (1997)), where the denominator is net plant, property, and equipment (PP&E). Our approach matches our sample, which includes smaller and non-manufacturing firms with modest fixed assets, and our measures of investment, which include intangible assets. Nevertheless, we show in our robustness tests below that scaling by PP&E leads to very similar results.

[12] We have conducted a variety of tests to determine whether our particular treatment of outliers makes any difference. As it turns out, all that matters is that we do something to tamp down the most extreme realizations of *Q*, which in the raw data attains a maximum value of 52.5. An alternative to Winsorizing is to replace the book value of equity in *Q* with 0.9 times the book value plus 0.1 times the market value, thereby bounding the transformed value of *Q* below 10. This procedure gives virtually identical results to those we report. (We thank Tuomo Vuolteenaho for suggesting this procedure.)

in book equity (ΔItem 6-ΔItem 60-ΔItem 74). These variables are also Winsorized at the 1st and 99th percentile.

Panel B of Table 1 shows summary statistics for financing. These mean values are sensitive to major financing events such as acquisitions and divestitures, despite the Winsorization and the restriction on minimum book assets. The medians look more familiar. The medians are also stable across the 1980s and 1990s (not reported).

C. Equity dependence

Following Lamont, Polk and Saa-Requejo (2001), we construct the five-variable KZ index for each firm-year as the following linear combination:

$$KZ_{it} \text{ (five variable)} = -1.002\frac{CF_{it}}{A_{it-1}} - 39.368\frac{DIV_{it}}{A_{it-1}} - 1.315\frac{C_{it}}{A_{it-1}} + 3.139 LEV_{it} + 0.283 Q_{it} \quad (4)$$

where CF_{it}/A_{it-1} is cash flow (Item 14+Item 18) over lagged assets; DIV_{it}/A_{it-1} is cash dividends (Item 21+Item 19) over assets; C_{it}/A_{it-1} is cash balances (Item 1) over assets; LEV_{it} is leverage ((Item 9+Item 34)/(Item 9+Item 34+Item 216)); and Q is the market value of equity (price times shares outstanding from CRSP) plus assets minus the book value of equity (Item 60+Item 74) all over assets.[13] We Winsorize the ingredients of the index before constructing it.

For reasons discussed above, our baseline specifications use a four-variable version of this index which omits Q. Henceforth, when we refer to the "KZ index," we mean this modified version, unless otherwise specified. We denote this version simply by KZ_{it}:

$$KZ_{it} = -1.002\frac{CF_{it}}{A_{it-1}} - 39.368\frac{DIV_{it}}{A_{it-1}} - 1.315\frac{C_{it}}{A_{it-1}} + 3.139 LEV_{it} \quad (5)$$

[13] As with investment, we scale the components of the KZ index by assets rather than net plant, property, and equipment (Item 8), because our sample includes small and non-manufacturing firms. Although assets produce fewer outliers in the raw KZ index, the results are similar with either denominator, as we show in robustness tests.

In some of our additional tests, we consider two other variables that may help to pinpoint equity-dependent firms. AGE_{it} is the number of years since the firm's IPO, defined as the current year minus the first year Compustat reports a non-missing market value of equity. As discussed above, this variable may be useful as a proxy for reputation and access to lending markets. $Industry\sigma(CF/A)_i$ is the industry average standard deviation of cash flows. We calculate the standard deviation of cash flows across the subset of firm-year observations for each industry using the industry definitions in Fama and French (1997). This measure may help to capture variation in debt capacity that is missed by the KZ index.

Panel A of Table 2 shows summary statistics for the KZ index, its four ingredients, and the other two equity-dependence proxies. By multiplying the coefficients in equation (5) by the standard deviation of the components, one can see that the KZ index is especially sensitive to variation in dividends and leverage.

D. Other investment determinants

Following Fazzari, Hubbard, and Petersen (1988) and many others, our baseline investment equation includes year fixed effects, firm fixed effects, start-of-year Q, and contemporaneous cash flow. Q and cash flow are as defined above.

IV. Empirical results

A. Hypothesis 1: Investment

We begin with a simple test of Hypothesis 1, which predicts that the investment of equity-dependent firms is more sensitive to their stock prices than that of non-equity-dependent firms. We assign each firm to a quintile according to its median value of KZ_{it} over the full sample period.[14] For each KZ quintile, we then estimate the following investment equation:

$$\frac{CAPX_{it}}{A_{it-1}} = a_i + a_t + bQ_{it-1} + c\frac{CF_{it}}{A_{it-1}} + u_{it}\ . \qquad (6)$$

Hypothesis 1 predicts that the stock-price-sensitivity coefficient *b* will generally increase as KZ increases.

Figure 1 and Panel A of Table 3 show that there is indeed a strong relationship between KZ and the effect of stock prices on investment. The coefficient *b* rises from 0.010 in the first quintile to 0.028 in the fifth quintile. Thus, the firms that are most likely to be equity dependent according to the KZ index have a sensitivity of investment to stock prices that is almost three times as large as firms that are unlikely to be equity dependent.

The pattern of *b* coefficients is our main result, but as an aside it is also interesting to look at the pattern of *c* coefficients in Panel A of Table 3. Consistent with the small-sample results of Kaplan and Zingales (1997), we find no discernible pattern in this coefficient across the KZ quintiles. It is almost the same in quintile 1 (0.122) as in quintile 5 (0.154), and bounces around non-monotonically in between. This particular result, however, is sensitive to the nature of the specification. If we keep everything else the same and lag the cash-flow term one year (so that we are using CF_{it-1}/A_{it-2} instead of CF_{it}/A_{it-1}) the cash-flow coefficient *c* now shows a pronounced increasing pattern, going from 0.044 in quintile 1 to 0.138 in quintile 5 (not

[14] Our results are not sensitive to the technique used to classify firm-year observations. In our robustness checks below, we experiment with two alternatives. In the first, we allow a firm's KZ quintile to vary from year to year, so, for example, if its leverage increases, it may move to a higher quintile. In the second, we assign firms to quintiles based on their median values of the index over five-year sub-periods, rather than over the full sample period. Both of these alternatives lead to very similar results.

reported). The pattern of *b* coefficients, on the other hand, is essentially unaffected by this variation: it now goes from 0.012 to 0.030 across the five quintiles (not reported).[15]

To get a better understanding of economic magnitudes, note from Table 2 that the standard deviation of *Q* in our sample is 0.91. Thus in the highest KZ quintile, the impact of a one-standard-deviation shock to *Q* is to alter the ratio of capital expenditures to assets by 0.025 (0.028 x 0.91 = 0.025). When compared to either the median or the standard deviation of this investment ratio (0.0598 and 0.0780, respectively), this effect is clearly substantial. As another benchmark, note that the standard deviation of the cash-flow-to-assets ratio is 0.117, so that in the highest KZ quintile, a one-standard-deviation shock to cash flow moves the investment ratio by 0.018 (0.154 x 0.117 = 0.018). Thus among the firms most likely to be equity dependent, stock prices have a slightly larger effect on investment than does cash flow. This contrasts with a general belief that cash flow uniformly dominates *Q* in these sorts of investment equations.

Turning to statistical, as opposed to economic significance, there are a couple of ways to evaluate the precision of our results. First, and most simply, we can do a t-test of the difference between our quintile-1 and quintile-5 *b* coefficients. Based on the standard errors from our regressions, (which are heteroskedasticity-robust, and clustered at the firm level in an effort to deal with potential serial correlation) the t-statistic is 4.43, which is highly significant.

An alternative approach, in the spirit of Fama and MacBeth (1973), can be used if one is very concerned about serial correlation at the firm level and does not trust the cluster adjustment to deliver proper standard errors. This approach is illustrated in Figure 2. Using the same

[15] We use the specification with a contemporaneous cash-flow term as our baseline for two reasons. First, this seems to be the convention in the literature. Second, we are interested in having the cash-flow term be as good a control as possible for fundamentals, not in making structural inferences with respect to it. This suggests that we should use the most recent cash-flow information available. In contrast, if the goal were to test whether cash flow has a causal impact on investment controlling for investment prospects, this approach might be less palatable, precisely because of contemporaneous cash flow's informativeness about future profitability.

methodology as before, we now divide the firms up into twenty KZ-index groups, instead of five. For each group, we estimate the *b* coefficient of investment on stock prices, just as we did previously. We then regress these twenty *b* estimates against their respective ordinal KZ-index rankings. In other words, we treat each *b* coefficient simply as a data point, without making any assumptions about the precision with which it is estimated. This twenty-data-point regression yields a point estimate of 0.0012 and a t-statistic of 6.44.[16] This estimate is roughly consistent with the effect of KZ that we found in the quintile regressions.

B. Robustness of Hypothesis 1 results

In Table 4 and Panel A of Table 5, we explore the robustness of our basic findings for investment. In Table 4, we continue to focus on capital expenditures as our measure of investment, but modify several other aspects of the specification. In each case, we report results that can be directly compared with those in Panel A of Table 3 – i.e., we report the *b* coefficient for each of the five KZ quintiles. Recall that in our baseline specification, this coefficient rises from 0.010 to 0.028 as we move from the bottom to the top quintile.

The first modification is to revert to the original five-variable KZ index used in Lamont, Polk and Saa-Requejo (2001), which includes *Q*. In this case, the *b* coefficient goes from 0.009 in quintile 1 to 0.023 in quintile 5, which differs little from our baseline result. Second, going back to our baseline four-variable version of the index, we try classifying firms based on their 5-year median value of KZ, as opposed to their median over the entire sample period. This again leads to results almost identical to the base case. Next, we push this time-varying classification logic one step further, and re-classify firms every year — specifically, a firm is assigned to a KZ

[16] Intuitively, with this method we infer that the *b* coefficients are precisely estimated by virtue of the fact that most of them cluster very close to the fitted regression line in Figure 2.

quintile in any given year *t* based on its value of the index in year *t-2*. Again, the estimates here are similar to those in the base case.

We consider two more variations. One is to scale everything by property, plant and equipment (PP&E), as opposed to by assets. This actually strengthens the results somewhat, with *b* more than quadrupling from 0.008 in the first quintile to 0.034 in the fifth quintile. Lastly, we add the lagged value of the capital-expenditure ratio to the right-hand-side. This brings down the *b* coefficients just slightly, but preserves their relative proportions.

In Panel A of Table 5, we consider how our basic results carry over to the three other measures of investment. To do this in a compact fashion, we pool the observations and run a series of interactive specifications of the form:

$$\frac{I_{it}}{A_{it-1}} = a_i + a_t + bQ_{it-1} + cQ_{it-1} \cdot KZ_i + d\,\frac{CF_{it}}{A_{it-1}} + u_{it} \tag{7}$$

where I_{it} denotes one of the four measures of investment, and KZ_i is the sample-median value of the KZ index for firm *i*. The coefficient of interest in this case is *c*, which is predicted to be positive. As can be seen, all four measures of investment yield qualitatively similar results.

C. Hypothesis 2: Investment and valuation

Hypothesis 2 predicts that the investment of *undervalued* equity-dependent firms is particularly sensitive to their stock prices. This is a more precise statement of the basic idea of the model, which is that undervaluation can induce a financial constraint on equity-dependent firms. This hypothesis is more difficult to test than Hypothesis 1, unfortunately, because it requires us to find some proxy for misvaluation (or, specifically, a proxy for *perceived* mispricing).

One useful proxy for misvaluation may be the level of Q itself. Several authors have interpreted the market-to-book ratio as a proxy for mispricing (Lakonishok, Shleifer, and Vishny (1994), La Porta (1996), and La Porta, Lakonishok, Shleifer, and Vishny (1997)). While this interpretation remains controversial, there is rather clear support for the use of market-to-book as a proxy for *perceived* mispricing. This is suggested by several empirical studies. First, managers state in surveys that mispricing is an important factor in the decision to issue equity (Graham and Harvey (2001)), and managers actually do tend to issue equity when the market-to-book ratio is high (Marsh (1982), Korajczyk, Lucas, and McDonald (1991), Pagano, Panetta, and Zingales (1998), and others). Also, managers tend to be net sellers in their personal account when their firm's market-to-book ratio is high (Jenter (2001)). Put together, these results suggest that a sensible approach to testing Hypothesis 2 would use market-to-book, or Q, as a proxy for perceived mispricing.

We therefore split the full sample into two subsamples, one containing low valuation firm-years ($Q < 2.00$) and another containing high valuation firm-years ($Q > 2.00$). The choice of 2.00 is admittedly arbitrary, but it seems necessary to set the breakpoint above unity to reflect such facts as intangible assets, inflation, and the aforementioned tendency among managers to view their firms as chronically undervalued.

Using our baseline specification, with capital expenditures as the investment measure, the coefficients in panels B and C of Table 3 (which are plotted in Figure 3) show the sensitivity of investment to stock prices in each of these subsamples. The results are generally consistent with Hypothesis 2. In the low valuation sample, the sensitivity of investment to stock prices is strongly increasing in the KZ index, whereas the effect is small or nonexistent in the high valuation sample. Thus it appears that our results for the full sample are almost entirely driven by the low valuation firms, as predicted by the model. Panel C of Table 3 also shows that the sensitivity of investment to stock prices is lower in general in the high valuation sample. This is consistent with another feature of the model, that investment is a fixed constant when $\delta > 0$ – or, said more realistically, that investment is sensitive to stock prices in this region only to the extent that they reflect investment opportunities as opposed to perceived mispricing.

Panels B and C of Table 5 repeat the same sample-split exercise, but vary the measure of investment in the pooled interactive specification. The basic picture in Figure 3 emerges in every case: the sensitivity of investment to stock prices increases strongly with the KZ index among low valuation firms, but much less so among high valuation firms.

Although the results of the valuation splits are consistent with Hypothesis 2, we are hesitant to make them our central focus. The reason is a twist on the Poterba (1988) measurement-error critique. It is possible that Q is a poorer proxy for investment opportunities when it is high, so measurement error could also lead to the sort of differences that we observe in the valuation splits. This is why we view Hypothesis 1 as the most straightforward test of the model, and Figure 1 (and the associated variations and robustness tests that we have presented) as the most compelling empirical result. Nevertheless, it is reassuring that the results are at least consistent with Hypothesis 2.

D. Decomposing KZ and the effect of other equity-dependence indicators

One hypothesis that we have maintained, not derived, is that the KZ index is a useful measure of equity dependence. One way to examine this hypothesis is by decomposing our previous results, checking how each of the four components of our KZ index is affecting the stock-price sensitivity. If each component works in the way suggested by our model, we can be more confident that the index is measuring equity dependence, as opposed to a confounding pattern of measurement errors or technological adjustment costs.

To perform the KZ index decomposition, we again pool all observations, and run the following interactive specification, which is analogous to that in Table 5:

$$\frac{I_{it}}{A_{it-1}} = a_i + a_t + bQ_{it-1} + Q_{it-1} \cdot \left[c_1 \frac{CF}{A} + c_2 \frac{DIV}{A} + c_3 \frac{C}{A} + c_4 LEV \right]$$

$$+ \left[d_1 \frac{CF}{A} + d_2 \frac{DIV}{A} + d_3 \frac{C}{A} + d_4 LEV \right] + e \frac{CF_{it}}{A_{it-1}} + u_{it} \qquad (8)$$

where the un-subscripted versions of the variables *CF/A*, *DIV/A*, *C/A*, and *LEV* refer to sample-median values for firm *i*. We run this regression for each of four measures of investment. The theoretical definition of equity dependence makes predictions for the signs of the interactions: c_1 should be negative, as should c_2 and c_3. In contrast, c_4 should be positive.

Panel A of Table 6 shows that the predictions for c_1, c_2, c_3 and c_4 are largely borne out. The sharpest results are for c_4, the interaction on the leverage term. Across all four definitions of investment, c_4 is always significantly positive, indicating a strong tendency for levered firms to have investment that is more sensitive to stock prices. The results for c_1, c_2 and c_3 are somewhat weaker, but overall consistent with the theory — in nine out of twelve possible cases the coefficients have the predicted sign, and in seven of these they are statistically significant.

In Panel B we consider two other potential proxies for equity dependence that are not included in the KZ index: firm age and industry cash flow volatility. We re-estimate equation (8) augmented with these variables and their interactions with *Q*, denoting the interaction coefficients as c_5 and c_6, respectively. We predict that c_5 will be negative, on the premise that younger firms are more likely to be dependent on equity. And we predict that c_6 will be positive, since higher cash flow volatility implies lower debt capacity, which again contributes to equity dependence. The results in Panel B strongly support these predictions. Both c_5 and c_6 have the expected sign for all measures of investment, and are highly significant in virtually all cases.

This exercise indicates that the earlier results for the composite KZ index reflect generally helpful contributions from each of its four components: cash flow, dividends, cash on hand, and leverage, with leverage playing the strongest and most consistent role. The results also cast doubt on generic measurement-error or adjustment-cost explanations: One would have to argue that measurement error or adjustment costs are simultaneously increasing in some of these variables and decreasing in certain others, in just the way that the KZ index is defined.

Overall, the results provide a detailed picture of the type of firm that is likely to have a high sensitivity of investment to stock prices: a young, non-dividend-paying firm, with low cash flow and cash balances, and with high leverage *relative* to the debt capacity of its assets. This picture fits the theoretical definition of equity dependence rather well.

E. Hypothesis 3: Financing and valuation

Our last hypothesis is that equity issuance by undervalued, equity-dependent firms is particularly sensitive to their stock prices. If so, this would be further evidence that our earlier results for investment are coming through the specific equity financing channel in the model. We test this hypothesis within the same regression framework as before, simply changing the dependent variable from investment to financing.

In the first three rows of Table 7, the financing variable is equity issues over assets, e_{it}/A_{it-1}. The first row indicates that for all firms, the sensitivity of equity issuance to stock prices rises from 0.019 in the first KZ quintile to 0.057 in the fifth quintile. Thus, averaging across all valuation levels, firms classified as most likely to be equity dependent have equity issuance that is much more closely tied to their stock prices. This is the same pattern as for investment.

Hypothesis 3 makes the more specific prediction that this same kind of pattern should hold among undervalued firms.[17] To test this we again split the sample according to whether Q is above or below 2.00. The second row of Table 7 shows the results. As predicted, low-valued firms that score high on the KZ index have equity issues that are especially sensitive to stock prices. In the top quintile of the low valuation sample the sensitivity is 0.076, which is substantially greater than the bottom quintile figure of 0.027.

The model does not imply that equity-dependent firms finance 100% of their marginal investment with equity issues, of course. According to Proposition 1, in the relevant region of the parameter space (iii.a) the leverage constraint is binding, so at the margin new equity and debt are raised in proportions $(1-\overline{D})$ and $\overline{D}$ respectively. This suggests the testable prediction that equity-dependent firms should also be raising a significant amount of debt on the margin.

We examine this prediction using a total external finance variable that includes both equity and debt issues, $(e_{it}+d_{it})/A_{it-1}$. The results are in the fourth row of Table 7. They show that for firms in KZ quintile 5, the sensitivity of total external finance to stock prices is 0.110, whereas for equity issues alone it is 0.057. In other words, for high-KZ firms, a marginal increase in the stock price leads to almost exactly equal increases in equity and debt finance. (The sensitivity of debt issuance to stock prices is 0.110 – 0.057 = 0.053.) This seems consistent with the model's prediction that equity-dependent firms issue equity and debt in lock step.

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[17] It should be noted again, however, that the model does not predict the absence of such a pattern among overvalued firms. Unlike in the case of investment, the model is less clear-cut with respect to its predictions for the equity-issuance behavior of overvalued firms. See footnote 7.

The results here generally support Hypothesis 3 and reinforce the case that the earlier findings for investment are substantially driven by the specific equity financing channel outlined in the model. As predicted by the model, equity issues are especially sensitive to stock prices among low-valued, high-KZ firms, and debt issues appear to move roughly in lock step as these equity issues create debt capacity on the margin.

V. Conclusion

A great deal of research has been devoted to understanding why stock prices are correlated with investment. The traditional view, embodied in the *Q* theory of investment, emphasizes the role of stock prices as indicators of investment opportunities. An alternative view posits the existence of some equity financing channel in which the cost of external equity has an independent effect on investment. Empirical attempts to determine the relative merits of these two views have not been very successful, however. One reason why is that the equity financing channel is usually not articulated in a form that yields distinct empirical predictions.

In this paper, we use a version of the Stein (1996) model to develop a specific, testable version of the equity financing channel. The main cross-sectional prediction of the model is that firms that need external equity to finance their legitimate investment opportunities – "equity-dependent firms" – will have investment that is especially sensitive to the non-fundamental component of stock prices. This prediction reflects, in part, the idea that undervaluation increases the effective cost of external equity and therefore deters investment by equity-dependent firms. The model also offers other predictions that are distinct from the *Q* theory.

We test the model using a version of the index developed by Kaplan and Zingales (1997) to identify equity-dependent firms. The main empirical result is that firms that rank in the top quintile of the KZ index have investment that is almost three times as sensitive to Q as firms in the bottom quintile. We also find support for several other implications of the model. For example, the effect of equity dependence is much stronger in a sample of firms that is more likely to be undervalued. In addition, equity issues by equity-dependent firms are also more sensitive to stock prices, consistent with the mechanism in the model.

The results complement other recent research on how the cost of external equity – particularly the component that is irrational, or perceived as such by managers – drives patterns in equity issues, capital structure, or merger activity. But they are of perhaps greater economic importance than those findings pertaining purely to financing patterns, because they suggest how stock market inefficiency may affect the real economy.

If one takes our model literally, it might be tempting to conclude that the investment behavior of equity-dependent firms must necessarily be less efficient on average than that of non-equity-dependent firms. After all, according to the model, non-fundamental movements in stock prices introduce volatility into the investment of the equity-dependent firms, thereby moving them away from the first best. But we caution readers against rushing to this sort of welfare conclusion, because it is quite sensitive to the perhaps unrealistic assumption that, absent financial constraints, managers always act in the best interests of their stockholders.

Consider the following embellishment of the model. Everything else is as before, except that unconstrained managers are subject to an agency problem that leads them to prefer excessively smooth investment in the face of changes in fundamentals. If one layers on top of this agency problem our equity-financing channel, the same basic *positive* implications emerge: all else equal, the investment of equity-dependent firms will respond more to stock prices than that of non-equity-dependent firms. But the *normative* implications of the model will be very different. Since the non-equity-dependent firms are now underreacting to stock prices, the investment of the equity-dependent firms may be closer to efficient on average.[18] In other words, starting from a second-best situation, the distortion inherent in the equity-financing channel may help to alleviate the distortion coming from managers' tendency to smooth investment.

[18] Indeed, researchers commonly associate a greater sensitivity of investment to stock prices with a *higher* degree of efficiency. See, e.g., Scharfstein (1998) and Rajan, Servaes and Zingales (2000) for examples in the context of internal capital markets.

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Figure 1. Equity dependence and investment. Plot of the sensitivity of investment to market value by equity dependence quintile. We sort firms into five quintiles according to the firm median Kaplan and Zingales (1997) index of financial constraints (excluding Q from the index) over the period from 1980 to 1999, performing separate regressions for each quintile. Year and firm fixed effects are included.

$$\frac{CAPX_{it}}{A_{it-1}} = a_i + a_t + bQ_{it-1} + c\frac{CF_{it}}{A_{it-1}} + u_{it}$$

We plot estimates of b. Investment is defined as capital expenditures over assets. Q is defined as the market value of equity plus assets minus the book value of equity over assets. Cash flow is defined as operating cash flow over assets.

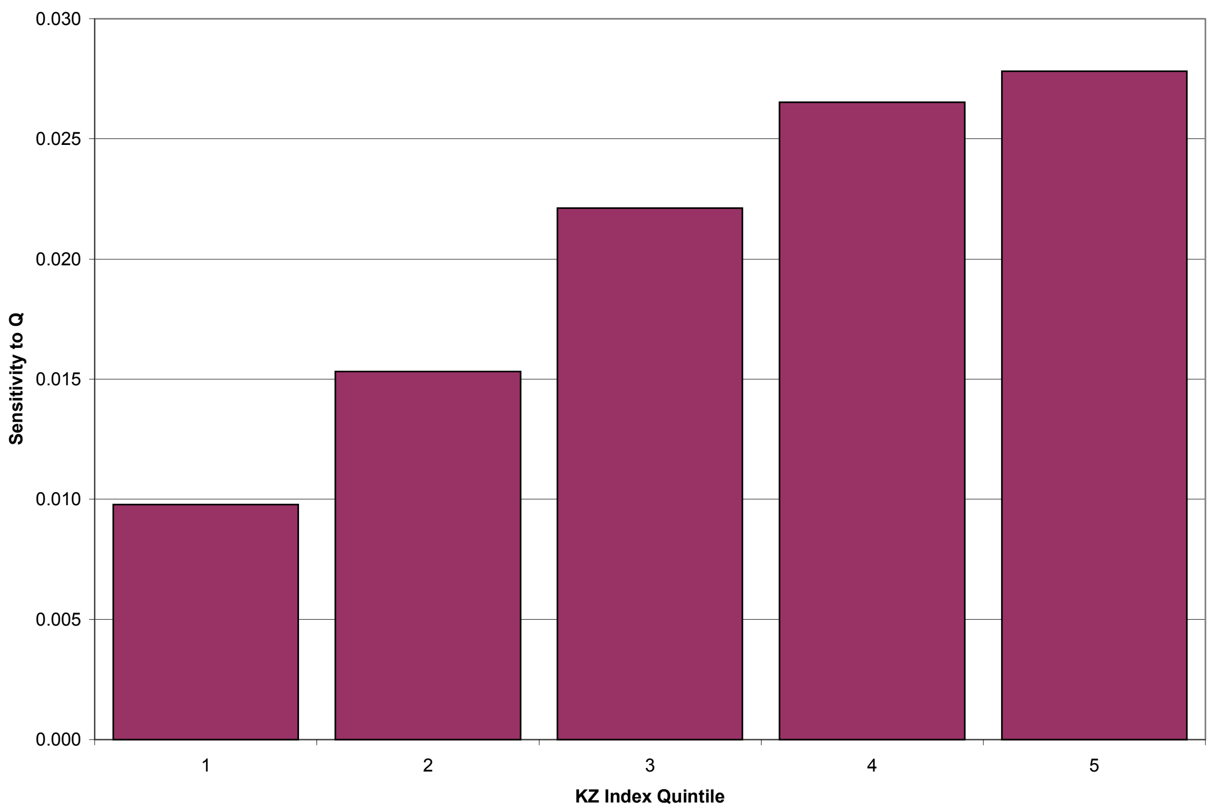


Figure 2. Equity dependence and investment. Plot of the sensitivity of investment to market value by equity dependence group. We sort firms into twenty groups according to the firm median Kaplan and Zingales (1997) index of financial constraints (excluding Q from the index) over the period from 1980 to 1999, performing separate regressions for each group. Year and firm fixed effects are included.

$$\frac{CAPX_{it}}{A_{it-1}} = a_i + a_t + bQ_{it-1} + c\frac{CF_{it}}{A_{it-1}} + u_{it}$$

We plot estimates of b. Investment is defined as capital expenditures over assets. Q is defined as the market value of equity plus assets minus the book value of equity over assets. Cash flow is defined as operating cash flow over assets. We report the slope estimate and the t-statistic from an OLS regression of the b estimates on KZ index group.

Q coefficients (slope = 0.0012 [6.44])

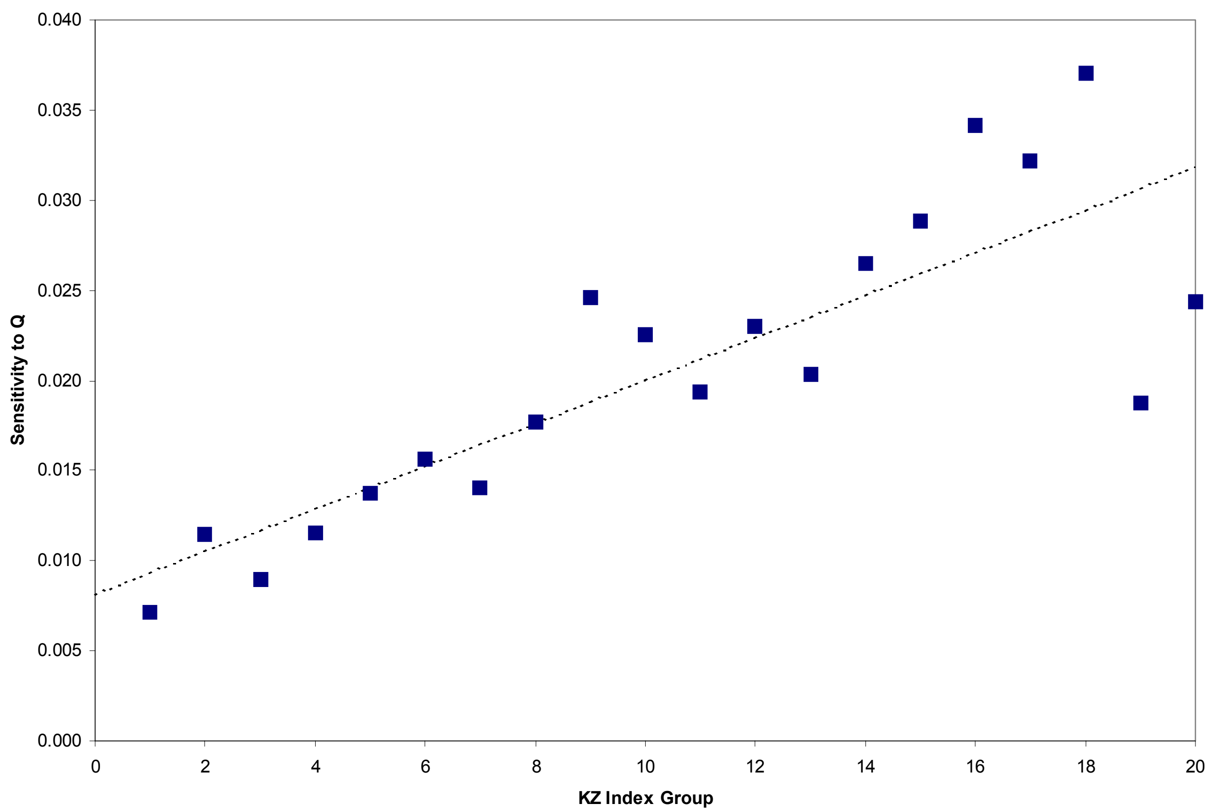
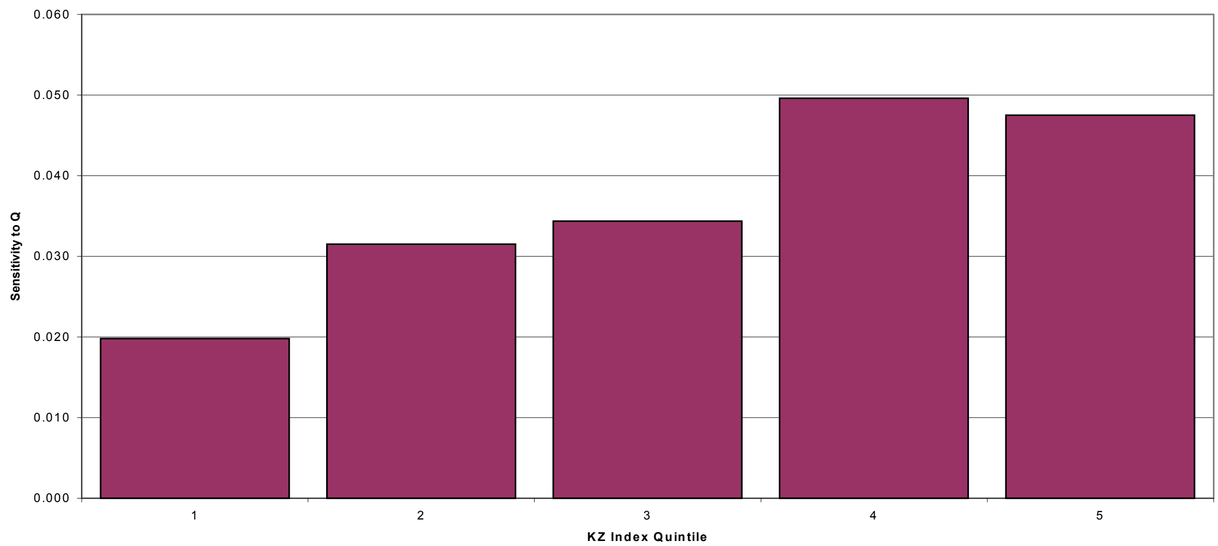


Figure 3. Equity dependence and investment, by valuation level. Plot of the sensitivity of investment to market value by equity dependence quintile and valuation level. We sort firms into five quintiles according to the firm median Kaplan and Zingales (1997) index of financial constraints (excluding Q from the index) over the period from 1980 to 1999. Within each quintile, we sort firms by valuation level according to whether Q is below or above 2.00. We then perform separate regressions for each of these ten groups. Year and firm fixed effects are included.

$$\frac{CAPX_{it}}{A_{it-1}} = a_i + a_t + bQ_{it-1} + c\frac{CF_{it}}{A_{it-1}} + u_{it}$$

We plot estimates of b. Investment is defined as capital expenditures over assets. Q is defined as the market value of equity plus assets minus the book value of equity over assets. Cash flow is defined as operating cash flow over assets. Panel A shows results for firms with Q below 2.00. Panel B shows results for firms with Q above 2.00.

A. Low valuation firms



B. High valuation firms

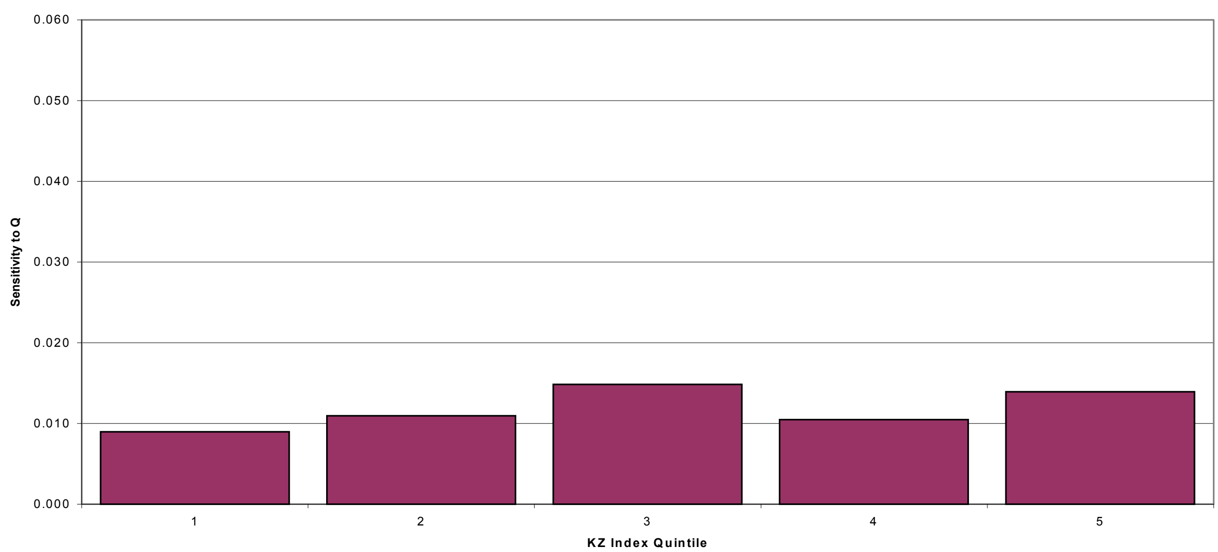


Table 1. Summary statistics of investment and financing. In Panel A, investment is alternately defined as capital expenditures (Item 128) over assets (Item 6); capital expenditures plus research and development expenses (Item 46) over assets; capital expenditures plus research and development expenses plus selling, general, and administrative expenses (Item 189) over assets; and growth in assets. In Panel B, financing is defined separately as equity issues (ΔItem 60+ΔItem 74-ΔItem 36) (i.e. the change in book equity minus the change in retained earnings) over assets, and equity issues plus debt issues (ΔItem 6-ΔItem 60-ΔItem 74) over assets. All variables are Winsorized at the 1st and 99th percentiles.

	Full Sample						*Subsample Means*	
	N	**Mean**	**SD**	**Median**	**Min**	**Max**	**1980-89**	**1990-99**
				Panel A: Investment				
$CAPX_t/A_{t-1}$ %	51,982	8.20	7.80	5.98	0.18	44.70	8.76	7.77
$+RD_t/A_{t-1}$	51,982	11.37	10.41	8.42	0.24	58.14	10.90	11.72
$+RD_t+SGA_t/A_{t-1}$	51,982	40.02	28.85	34.17	1.62	143.48	39.06	40.74
$\Delta A_t/A_{t-1}$ %	51,982	11.08	28.10	6.38	-44.16	154.09	10.20	11.76
				Panel B: Financing				
e_t/A_{t-1} %	51,982	4.38	14.63	0.64	-16.31	93.73	2.95	5.48
$+d_t/A_{t-1}$	51,982	10.47	27.62	3.99	-34.74	164.53	8.35	12.09

Table 2. Summary statistics of equity dependence and other investment determinants. Equity dependence is defined using the Kaplan and Zingales (1997) index of financial constraints (excluding *Q* from the index). This modified version of the index has four components: cash flow (Item 14+Item 18) over assets; cash dividends (Item 21+Item 19) over assets; cash balances (Item 1) over assets; and leverage ((Item 9+Item 34)/(Item 9+Item 34+Item 216)). We also consider two additional measures of equity dependence, firm age and the industry standard deviation of cash flow over assets between 1980 and 1999. Industry definitions follow Fama and French (1997). Age is equal to the current year minus the IPO year, which is defined as the first year Compustat reports a non-missing market value of equity. *Q* is defined as the market value of equity (price times shares outstanding from CRSP) plus assets minus the book value of equity (Item 60+Item 74) over assets. All variables are Winsorized at the 1^{st} and 99^{th} percentiles except for firm age and the industry standard deviation of cash flow.

	Full Sample						*Subsample Means*	
	N	**Mean**	**SD**	**Median**	**Min**	**Max**	**1980-89**	**1990-99**
Panel A: Equity Dependence Variables (*t-2*)								
KZ Index	51,982	0.12	1.82	0.27	-10.57	3.69	0.12	0.11
CF_{t-2}/A_{t-3} %	51,982	10.65	19.07	9.08	-40.18	137.26	10.50	10.76
DIV_{t-2}/A_{t-3} %	51,982	1.66	2.83	0.67	0.00	20.18	1.86	1.52
C_{t-2}/A_{t-3} %	51,982	14.00	26.03	5.05	0.01	185.73	11.00	16.28
LEV_{t-2} %	51,982	35.31	25.64	34.26	0.00	124.13	35.74	34.98
AGE_{t-2}	51,982	14.99	10.33	12.00	1.00	49.00	14.76	15.17
Industry $\sigma(CF/A)$	51,982	138.20	211.05	60.16	10.94	863.50	136.96	139.14
Panel B: Other Investment Determinants								
Q_{t-1}	51,982	1.46	0.91	1.16	0.53	6.07	1.26	1.60
CF_t/A_{t-1} %	51,982	8.19	11.70	9.18	-42.78	36.57	9.24	7.39

Table 3. Equity dependence and investment, full sample and by valuation level. Regressions of investment on market value and cash flow by equity dependence quintile. We sort firms into five quintiles according to the firm median Kaplan and Zingales (1997) index of financial constraints (excluding Q from the index), performing separate regressions for each group. Year and firm fixed effects are included.

$$\frac{CAPX_{it}}{A_{it-1}} = a_i + a_t + bQ_{it-1} + c\frac{CF_{it}}{A_{it-1}} + u_{it}$$

We report estimates of b and c. Investment is defined as capital expenditures over assets. Q is defined as the market value of equity plus assets minus the book value of equity over assets. Cash flow is defined as operating cash flow over assets. Panel A shows results for the full sample. We then sort firms within each quintile based on their values of Q in the prior year. Panel B shows results for firms with Q below 2.00. Panel C shows results for firms with Q above 2.00. T-statistics use heteroskedasticity-robust standard errors, clustered by firm, with all five regressions in a panel estimated simultaneously.

		Q_{t-1}		CF_t/A_{t-1}		
KZ index	**N**	**b**	**[t-stat]**	**c**	**[t-stat]**	**R^2**
			Panel A: All firms			
Quintile 1	10,398	0.010	[7.52]	0.122	[8.51]	0.56
2	10,407	0.015	[9.76]	0.133	[9.80]	0.55
3	10,385	0.022	[9.55]	0.126	[8.52]	0.52
4	10,402	0.027	[9.27]	0.143	[10.97]	0.54
5	10,390	0.028	[7.21]	0.154	[11.62]	0.53
			Panel B: Low valuation firms			
Quintile 1	7,286	0.020	[5.50]	0.133	[7.72]	0.56
2	8,396	0.032	[9.94]	0.157	[9.70]	0.56
3	9,148	0.034	[9.84]	0.144	[9.41]	0.50
4	9,426	0.050	[11.88]	0.146	[10.67]	0.53
5	9,619	0.047	[9.21]	0.164	[11.74]	0.52
			Panel C: High valuation firms			
Quintile 1	3,112	0.009	[4.55]	0.102	[4.10]	0.58
2	2,011	0.011	[3.84]	0.080	[3.22]	0.57
3	1,237	0.015	[3.88]	0.041	[1.12]	0.61
4	976	0.010	[2.19]	0.049	[1.51]	0.66
5	771	0.014	[2.64]	0.048	[1.50]	0.69

Table 4. Robustness: Equity dependence and investment. Regressions of investment on market value and cash flow by equity dependence quintile. We sort firms into five quintiles according to various modifications of the Kaplan and Zingales (1997) index of financial constraints, performing separate regressions for each group. Year and firm fixed effects are included.

$$\frac{CAPX_{it}}{A_{it-1}} = a_i + a_t + bQ_{it-1} + c\frac{CF_{it}}{A_{it-1}} + u_{it}$$

We report estimates of *b*. Investment is defined as capital expenditures over assets. *Q* is defined as the market value of equity plus assets minus the book value of equity over assets. Cash flow is defined as operating cash flow over assets. The first row is our baseline specification, which classifies firms according to their median four-variable KZ index (excluding *Q*); the second row uses the firm median five-variable KZ index (including *Q*); the third row uses a five-year median KZ index (excluding *Q*); and the fourth row uses an annual KZ index (measured at time *t-2*) excluding *Q*. The fifth row scales variables by fixed assets instead of total assets. The sixth row includes lagged investment as an independent variable. T-statistics use heteroskedasticity-robust standard errors, clustered by firm, with all five regressions in a row estimated simultaneously.

	Bottom Quintile		*2*		*3*		*4*		*Top Quintile*		*Top – Bottom*	
	b	**[t-stat]**	**b**	**[t-stat]**	**b**	**[t-stat]**	**b**	**[t-stat]**	**b**	**[t-stat]**	**Δb**	**[t-stat]**
1. KZ (base case)	0.010	[7.52]	0.015	[9.76]	0.022	[9.55]	0.027	[9.27]	0.028	[7.21]	0.018	[4.43]
2. KZ (five-variable)	0.009	[6.05]	0.016	[9.92]	0.018	[9.11]	0.023	[9.92]	0.023	[7.93]	0.014	[4.37]
3. KZ (five-year median)	0.009	[6.97]	0.016	[9.49]	0.019	[9.19]	0.027	[9.54]	0.029	[7.57]	0.019	[4.79]
4. KZ (annual)	0.009	[5.97]	0.015	[7.64]	0.022	[7.45]	0.029	[8.01]	0.029	[6.84]	0.020	[4.40]
5. PP&E Scaling	0.008	[7.12]	0.012	[8.65]	0.022	[10.61]	0.028	[9.24]	0.034	[9.37]	0.026	[6.81]
6. Lagged *CAPX/A* added	0.007	[6.25]	0.011	[7.60]	0.017	[8.43]	0.020	[7.71]	0.024	[6.68]	0.017	[4.50]

Table 5. Equity dependence and investment, full sample and by valuation level. Regressions of investment on market value, market value interacted with equity dependence, and cash flow. Year and firm fixed effects are included.

$$\frac{I_{it}}{A_{it-1}} = a_i + a_t + bQ_{it-1} + cQ_{it-1} \cdot KZ_i + d\frac{CF_{it}}{A_{it-1}} + u_{it}$$

Investment is alternately defined as capital expenditures over assets; capital expenditures plus research and development expenses over assets; capital expenditures plus research and development expenses plus selling, general, and administrative expenses over assets; and growth in assets. *Q* is defined as the market value of equity plus assets minus the book value of equity over assets. The measure of equity dependence is the firm median Kaplan and Zingales (1997) index of financial constraints (excluding *Q* from the index), standardized to have unit variance. Cash flow is defined as operating cash flow over assets. Panel A shows results for the full sample. Panel B shows results for firms with *Q* below 2.00. Panel C shows results for firms with *Q* above 2.00. T-statistics use heteroskedasticity-robust standard errors, clustered by firm.

		Q_{t-1}		$Q_{t-1} \cdot KZ$		CF_t/A_{t-1}		
	N	**b**	**[t-stat]**	**c**	**[t-stat]**	**d**	**[t-stat]**	R^2
				Panel A: All firms				
CAPX/A	51,982	0.019	[19.12]	0.007	[6.08]	0.137	[22.04]	0.54
+RD/A	51,982	0.026	[18.95]	0.008	[5.83]	0.122	[14.19]	0.64
+RD+SGA/A	51,982	0.045	[16.13]	0.012	[3.10]	0.279	[15.72]	0.81
ΔA/A	51,982	0.074	[17.96]	0.037	[9.66]	1.149	[39.03]	0.31
				Panel B: Low valuation firms				
CAPX/A	43,875	0.036	[20.57]	0.013	[4.33]	0.151	[21.99]	0.53
+RD/A	43,875	0.041	[19.93]	0.016	[4.54]	0.152	[17.33]	0.59
+RD+SGA/A	43,875	0.058	[12.98]	0.025	[3.29]	0.346	[18.97]	0.82
ΔA/A	43,875	0.096	[14.30]	0.048	[4.09]	1.256	[39.00]	0.29
				Panel A: High valuation firms				
CAPX/A	8,107	0.011	[7.08]	0.000	[0.07]	0.067	[4.99]	0.63
+RD/A	8,107	0.018	[8.05]	0.002	[0.98]	0.010	[0.48]	0.71
+RD+SGA/A	8,107	0.037	[7.47]	0.001	[0.23]	0.096	[2.05]	0.77
ΔA/A	8,107	0.073	[7.91]	0.030	[5.08]	0.839	[10.76]	0.30

Table 6. Equity dependence decomposition. Regressions of investment on market value, market value interacted with the components of equity dependence, the components of equity dependence, and cash flow. Year and firm fixed effects are included.

$$\frac{I_{it}}{A_{it-1}} = a_i + a_t + bQ_{it-1} + Q_{it-1} \cdot \left[c_1 \frac{CF}{A}_i + c_2 \frac{DIV}{A}_i + c_3 \frac{C}{A}_i + c_4 LEV_i + c_5 \log(AGE_{i,t-1}) + c_6 \sigma\left(\frac{CF}{A}\right)\right] +$$

$$\left[d_1 \frac{CF}{A}_i + d_2 \frac{DIV}{A}_i + d_3 \frac{C}{A}_i + d_4 LEV_i + d_5 \log(AGE_{i,t-1}) + d_6 \sigma\left(\frac{CF}{A}\right)\right] + e\frac{CF_{it}}{A_{it}} + u_{it}$$

We report **c**. Investment is alternately defined as capital expenditures over assets; capital expenditures plus research and development expenses over assets; capital expenditures plus research and development expenses plus selling, general, and administrative expenses over assets; and growth in assets. Q is defined as the market value of equity plus assets minus the book value of equity over assets. Panel A decomposes the effect of the Kaplan and Zingales (1997) index (excluding Q) into its four components: firm median operating cash flow over assets; firm median dividends over assets; firm median cash balance over assets; and firm median leverage. Panel B adds two additional measures of equity dependence, firm age and the industry standard deviation of cash flow over assets between 1980 and 1999. All components of equity dependence are standardized to have unit variance. The first row indicates the sign the variable takes in the Kaplan and Zingales (1997) index. The second row indicates the predicted sign for **c**. T-statistics use heteroskedasticity-robust standard errors, clustered by firm.

	CF_{t-2}/A_{t-3}		DIV_{t-2}/A_{t-3}		C_{t-2}/A_{t-2}		LEV_{t-2}		$\log(AGE_{t-2})$		Industry σ (CF/A)	
	c_1	**[t-stat]**	**c_2**	**[t-stat]**	**c_3**	**[t-stat]**	**c_4**	**[t-stat]**	**c_5**	**[t-stat]**	**c_6**	**[t-stat]**
KZ Index	–		–		–		+					
Prediction	–		–		–		+		–		+	
Panel A: KZ index variables												
CAPX/A	0.003	[2.26]	-0.003	[-3.17]	-0.005	[-5.11]	0.006	[4.11]				
+RD/A	-0.002	[-0.90]	-0.003	[-2.30]	-0.004	[-2.66]	0.006	[3.27]				
+RD+SGA/A	-0.017	[-4.22]	0.005	[1.52]	0.000	[0.09]	0.019	[5.35]				
ΔA/A	-0.018	[-2.99]	-0.017	[-6.21]	-0.002	[-0.32]	0.021	[3.89]				
Panel B: Additional measures of equity dependence												
CAPX/A	0.003	[2.57]	-0.002	[-2.05]	-0.005	[-5.63]	0.004	[2.87]	-0.004	[-4.87]	0.007	[4.92]
+RD/A	-0.001	[-0.72]	-0.002	[-1.43]	-0.005	[-2.99]	0.004	[2.31]	-0.004	[-3.37]	0.007	[4.12]
+RD+SGA/A	-0.016	[-3.99]	0.007	[2.54]	-0.001	[-0.46]	0.019	[4.99]	-0.008	[-3.03]	0.004	[1.63]
ΔA/A	-0.017	[-2.87]	-0.014	[-4.69]	-0.003	[-0.66]	0.019	[3.36]	-0.013	[-3.78]	0.011	[2.88]

Table 7. Equity dependence and financing. Regressions of financing on market value and cash flow, by equity dependence quintile and valuation level. We sort firms into five quintiles according to the firm median Kaplan and Zingales (1997) index of financial constraints (excluding *Q*), performing separate regressions for each group. Year and firm fixed effects are included.

$$Financing_{it} = a_i + a_t + bQ_{it-1} + c\frac{CF_{it}}{A_{it-1}} + u_{it}$$

We report estimates of *b*. Financing is alternately defined as equity issues over assets and as equity plus debt issues over assets. *Q* is defined as the market value of equity plus assets minus the book value of equity over assets. Cash flow is defined as operating cash flow over assets. The first row shows results for equity issues for the full sample; the second row considers equity issues by firms with *Q* below 2.00; the third row considers equity issues by firms with *Q* above 2.00; the fourth row shows results for total external finance (equity plus debt) for the full sample. T-statistics use heteroskedasticity-robust standard errors, clustered by firm, with all five regressions in a row estimated simultaneously.

	Bottom Quintile		*2*		*3*		*4*		*Top Quintile*		*Top – Bottom*	
	b	**[t-stat]**	**b**	**[t-stat]**	**b**	**[t-stat]**	**b**	**[t-stat]**	**b**	**[t-stat]**	**Δb**	**[t-stat]**
External Equity – All Firms	0.019	[4.61]	0.046	[8.83]	0.038	[6.70]	0.050	[7.51]	0.057	[6.75]	0.038	[4.06]
External Equity – Low Value	0.027	[3.77]	0.037	[5.46]	0.057	[7.95]	0.057	[8.17]	0.076	[8.09]	0.049	[4.13]
External Equity – High Value	0.014	[2.12]	0.046	[4.17]	0.031	[2.14]	0.051	[2.77]	0.055	[2.28]	0.041	[1.66]
External Equity Plus Debt – All	0.034	[5.16]	0.071	[8.51]	0.082	[8.87]	0.096	[8.47]	0.110	[6.86]	0.076	[4.38]