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Abstract:

This paper explores whether and why misvaluation affects corporate investment by comparing tangible and intangible investments; and by using a price-based misvaluation proxy that filters out scale and earnings growth prospects. Capital, and especially R&D expenditures increase with overpricing; but only among overvalued firms. Misvaluation affects investment both directly (catering) and through equity issuance. The sensitivity of capital expenditures to misvaluation is stronger among financially constrained firms; for R&D this differential is strong and in the opposite direction. We identify several other factors that influence the strength of misvaluation effects on investment. Generally the equity channel reinforces direct catering, suggesting that the two are complementary. Overall, our evidence supports several implications of the misvaluation hypothesis for the tangible and intangible components of investment.

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This paper explores whether and why misvaluation affects corporate investment by comparing tangible and intangible investments; and by using a price-based misvaluation proxy that filters out scale and earnings growth prospects. Capital, and especially R&D expenditures increase with overpricing; but only among overvalued firms. Misvaluation affects investment both directly (catering) and through equity issuance. The sensitivity of capital expenditures to misvaluation is stronger among financially constrained firms; for R&D this differential is strong and in the opposite direction. We identify several other factors that influence the strength of misvaluation effects on investment. Generally the equity channel reinforces direct catering, suggesting that the two are complementary. Overall, our evidence supports several implications of the misvaluation hypothesis for the tangible and intangible components of investment.

1 Introduction

Both efficient and inefficient market theories imply that higher stock prices should be associated with higher corporate investment. Under the q theory of investment (Tobin (1969)), markets are efficient, so that a high stock price reflects strong growth opportunities. It follows that a high-priced firm should invest more.

Under what we call *the misvaluation hypothesis*, firms respond to overvaluation by investing more. Equity overvaluation can stimulate investment by encouraging the firm to raise more equity capital (Stein (1996), Baker, Stein, and Wurgler (2003), Gilchrist, Himmelberg, and Huberman (2005)), thereby exploiting new shareholders for the benefit of existing shareholders.[1] If the market overvalues the firm's new investment opportunities, the firm may commit to additional investment in order to obtain a high price for newly issued equity.

However, the misvaluation hypothesis does not require equity issuance. If a manager likes having a high short run stock price even at the expense of long-term value, he may invest heavily in order to stimulate or cater to optimistic market expectations (Stein (1996), Polk and Sapienza (2006), Jensen (2005)).

In this paper we test the misvaluation hypothesis using an approach designed to distinguish rational from misvaluation effects, and to probe into the sources of misvaluation effects. This approach is to test the relationship between investment and a single overall measure of misvaluation. A distinctive feature of how we identify misvaluation as a predictor of investment is that we examine the deviation of market price from a *forward-looking* measure of fundamental value.[2] Doing so filters from our misvaluation proxy the contaminating effects of prospects for future profit growth. Removing such contamination is crucial, since, as the q theory of investment implies, current investment should increase with the quality of investment opportunities; and because firms with better management teams optimally should invest more. In this respect our misvaluation

[1]Several authors provide evidence suggesting that firms time new equity issues to exploit market misvaluation, or manage earnings to induce such misvaluation—see, e.g., Ritter (1991), Loughran and Ritter (1995), Teoh, Welch, and Wong (1998b, 1998a), Teoh, Wong, and Rao (1998), Baker and Wurgler (2000), Henderson, Jegadeesh, and Weisbach (2006) and Dong, Hirshleifer, and Teoh (2007). There is also evidence that overvaluation is associated with greater use of equity as a means of payment in takeover (Dong et al. (2006)).

[2]In this respect our approach differs from that of Chirinko and Schaller (2001, 2006), who develop structural models of stock prices under efficient markets, in order to measure market misvaluation and its effect on corporate investment in Japan and the U.S.

measure minimizes the confounding of growth prospects and misvaluation effects that is present in many past studies of the stock market and investment.

To do so, we apply the residual income model of Ohlson (1995) to obtain a measure of fundamental value, sometimes called 'intrinsic value' (V), and measure misvaluation by V/P, the deviation of market price from this value.[3] Intrinsic value reflects not just current book value, but a discounted value of analyst forecasts of future earnings. Since intrinsic value reflects growth prospects and opportunities, normalizing market price by intrinsic value filters out the extraneous effects of firm growth to provide a purified measure of misvaluation.

In contrast, misvaluation measures such as Tobin's q or equity market-to-book rely for their fundamental benchmarks on a backward looking value measure, book value. Such valuation ratios therefore reflect information about the ability of the firm to generate high returns on its assets. Indeed, many studies have viewed Tobin's q or related variables as proxies for earnings growth prospects, investment opportunities, or managerial effectiveness. So it is hard to distinguish misvaluation from other rational effects based solely on q or market-to-book as misvaluation measures.[4] Furthermore, Tobin's q is a measure of total firm misvaluation (setting aside the confounding with growth prospects). However, a better measure of the firm's access to underpriced equity capital is its *equity* misvaluation.

Training a purer measure of misvaluation upon the misvaluation/investment relationship is only one of the two main purposes of this paper. The other main purpose here is to probe the economic sources of these effects. We do so in three ways. First, we test the distinctive predictions of the misvaluation hypothesis for tangible versus intangible investments. Second, we revisit in greater depth the issue of whether the effect of misvaluation on investment operates through equity issuance. Third, we examine how investment sensitivities to misvaluation vary across size, financial constraint, turnover, and valuation subsamples.

With regard to the first issue, we identify a sharp contrast between the effect of misvaluation on the creation of intangible assets through R&D investment and the effect

[3]This measure of misvaluation has been applied in a number of studies to the prediction of subsequent returns (Frankel and Lee (1998), and Lee, Myers, and Swaminathan (1999)), repurchases (D'Mello and Shroff (2000)), and takeover-related behaviors (Dong et al. (2006)).

[4]To the extent that our purification is imperfect, variation in our purified measure would still reflect firm growth rather than misvaluation. If this problem were severe we would expect our measure to have a high absolute correlation with q. In our sample, the correlation with q is not especially strong (-0.274). Nevertheless, as a further precaution, we additionally control for growth prospects as proxied by book-to-market in our tests.

on the creation of tangible assets through capital expenditures.[5] This is an important topic, since R&D is a source of business innovation, and quantitatively is a major component of corporate investment. Indeed, in our sample, beginning in the mid-1990's R&D constitutes a larger fraction of corporate investment than capital expenditures.

Under the misvaluation hypothesis, measured misvaluation should be most strongly related to the form of investment that investors are most prone to misvaluing. Intangible investments such as R&D presumably have relatively uncertain payoff, and therefore should tend to be relatively hard to value compared to ordinary capital expenditures.[6] Intangible investment projects will tend to present managers with greater opportunities for funding with overvalued equity, and for catering to project misvaluation. Thus, the misvaluation hypothesis predicts a stronger relation between misvaluation and R&D expenditures than between misvaluation and capital expenditures.

An integrated examination of equity issuance and investment offers insight into whether the effect of misvaluation on investment occurs because managers inherently seek to boost the stock price (a catering theory, as in Polk and Sapienza (2006)), or whether overvaluation encourages managers to issue equity (using such funds to invest more) in order to profit at the expense of new shareholders. Polk and Sapienza (2006) test between these possibilities by regressing capital expenditures on their misvaluation test variable, discretionary accruals, and including equity issuance as one of their controls. The effect of discretionary accruals survives the inclusion of equity issuance, so they conclude that there is a catering effect of misvaluation on capital expenditures.

However, if high market valuations cause the firm to issue more equity to finance investment, then equity issuance is an endogenous variable that is influenced by misvaluation. Thus, under the misvaluation hypothesis simple regressions tests for misvaluation effects that control for equity issuance are biased. It is therefore important to revisit the question of whether misvaluation affects investment through the equity channel versus

[5]The primary dependent variable in previous literature on misvaluation is the level of capital expenditures. Polk and Sapienza (2006) use the firm characteristic of high versus low R&D as a conditioning variable in some of their tests of the relation between misvaluation and capital expenditures. Baker, Stein, and Wurgler (2003) examine several measures of investment, one of which is the sum of capital expenditures and R&D, but do not examine whether misvaluation affects capital expenditures and R&D differently.

[6]Psychological evidence suggests that biases such as overconfidence will be more severe in activities (such as long-term research and product development) for which feedback is deferred and highly uncertain; see, e.g., Einhorn (1980). In the investment model of Panageas (2005), investment is most affected by market valuations when the disagreement about the marginal product of capital is greatest. Furthermore, there is evidence that greater valuation uncertainty is associated with stronger behavioral biases in the trades of individual investors (Kumar (2006)).

catering. We do so using a 2-Stage Least Squares procedure.

We apply such a procedure each year and pool the estimates across time as in Fama and MacBeth (1973). Empirically, we find that more positive mispricing is associated with greater capital expenditures and, very strongly, greater R&D. These findings remain after controlling for several other possible determinants of investment, including growth opportunities (proxied by q or equity book-to-market)[7], cash flow, leverage, and return volatility. In regression tests, the sensitivity of R&D to misvaluation is about 4-5 times greater than the sensitivity of capital expenditures.

When we employ simple OLS regressions within our Fama-MacBeth tests, controlling for equity issuance makes little difference for the relation between misvaluation and capital expenditures, and between misvaluation and R&D. This might seem to imply that the misvaluation effect on investment does not operate through equity issuance. However, when we address the endogeneity of equity issuance using 2-stage least squares, the conclusion is quite different; about half of the effect of misvaluation on investment occurs through equity issuance.

Thus, our evidence is consistent with the hypothesis that overvaluation induces firms to raise cheap equity capital to finance investment, consistent with the models of Stein (1996) and Baker, Stein, and Wurgler (2003). At the same time, consistent with the theory of Jensen (2005) and the model of Polk and Sapienza (2006), misvaluation effects do not operate solely through the equity channel. In other words, our evidence is consistent with misvaluation affecting investment for other reasons as well, such as a catering incentive to boost the short-term stock price.

With regard to the third issue, we probe further into the sources of the misvaluation effect by considering different subsamples which, under different hypotheses, should affect the strength of the misvaluation/investment relation. The sorting variables for identifying subsamples include measures of financial constraints, share turnover, firm size, and the degree of misvaluation.

Baker, Stein, and Wurgler (2003) find that the capital expenditures of financially constrained firms (where financial constraint is measured using the index of Kaplan and Zingales (1997)) are more sensitive to stock price than the capital expenditures of less constrained firms. Using our purified measure of misvaluation, equity V/P, we find that capital expenditures of financially constrained firms are more sensitive to market

[7]Tobin's q and equity book-to-market should be correlated with misvaluation as well as growth. Controlling for these variables therefore provides conservative tests for misvaluation effects. Also, we employ equity book-to-market rather than market-to-book in our tests for reasons discussed in Section 2.2).

misvaluation than that of non-constrained firms, consistent with the hypothesis of Baker, Stein, and Wurgler (2003).[8]

The findings for *in*tangible investments are much stronger, and contrast sharply. We find that the R&D expenditures of financially constrained firms (high KZ index) are *less* sensitive to market misvaluation than that of non-distressed firms. A possible explanation for the contrast between the findings for capital expenditures and for R&D is that distressed firms are ill-positioned to take advantage of opportunities to build intangible assets, both because such assets generate real options which require future financial flexibility, and because stakeholders such as employees, suppliers, or customers are reluctant to commit to long-term relationships (Titman (1984)). Indeed, Bhagat and Welch (1995) find an inverse relationship between leverage and R&D among U.S. firms. The absence of complementary inputs from stakeholders for such initiatives suggests that among financially constrained (high-KZ) firms R&D will be less sensitive to overvaluation than among low-KZ firms.

Polk and Sapienza (2006) propose that the sensitivity of investment to misvaluation should be higher when managers have a stronger focus on short-run stock prices, because a short term horizon makes overvalued projects more attractive. Polk and Sapienza use turnover as a proxy for short-term focus by shareholders. We find that the sensitivity of R&D, but not capital expenditures, to misvaluation is higher among high-turnover firms. This suggests that pressures to maintain short-term valuation are more important for intangible than for tangible investment. Our finding for capital expenditures contrasts with Polk and Sapienza's finding (based on a different proxy for misvaluation) of higher sensitivity among high-turnover firms; see footnote 22.

There are also reasons to expect the effects of misvaluation on investment to depend on firm size. Small firms may be more prone to misvaluation than large firms because of lower transparency. On the other hand, small firms have less access to equity markets, potentially limiting their ability to respond to overvaluation by issuing equity to increase investment. We find that small firms have higher sensitivity of R&D, but not capital expenditures, to misvaluation than large firms. The stronger effect of R&D suggests that catering (which is likely to be especially important for intangible investments) is more important for small firms.

[8]Baker et al also perform tests using future realized stock returns to proxy for prior misvaluation. These tests are not their primary focus, presumably because it is challenging to identify an appropriate benchmark for risk adjustment–the risk of a stock is likely to be correlated with investment, leverage, and financial constraints. However, it is encouraging that both contemporaneous and ex post proxies for misvaluation provide confirmation of the Baker, Stein, and Wurgler (2003) model.

Finally, when there are fixed costs of issuing equity, overvalued firms should be more likely to issue than undervalued firms. A marginal shift in misvaluation does not change the scale of equity issuance for a firm that refrains from issuing equity at all. So among undervalued firms, we expect a relatively small effect on issuance and investment of a reduction in the undervaluation. A similar point holds if projects have a minimum efficient scale. In contrast, when overvaluation is sufficient to induce project adoption, greater overvaluation encourages greater scale of issuance and investment. Alternatively, managers of overvalued firms may be particularly anxious to undertake overvalued investments in order to cater to optimistic investor perceptions (Jensen (2005)). These arguments all imply that misvaluation has a stronger marginal effect on investment among overvalued firms. We test this hypothesis by sorting firms based upon V/P ratios, and examining the relation of investment to valuation within quintiles. Consistent with the hypothesis, we find that it is only among overvalued firms that misvaluation affects capital expenditures, R&D, or total investment.

Subsample analysis provides further insight about the importance of catering versus expropriation through equity issuance as motives for investing. For capital expenditures, the indirect effect of misvaluation through equity issuance is strong only among financially constrained firms, consistent with the Baker, Stein, and Wurgler (2003) model. The direct effect (catering) is strong mainly among financially constrained firms, and among overvalued firms. The strength of the direct effect among overvalued firms is consistent with the hypothesis that catering incentives (the pressure to maintain a high stock price) is especially strong among overvalued firms (Jensen (2005)).

For R&D, the indirect effect of misvaluation is strongest among firms that are less financially constrained, and for the kinds of firms (overvalued, high turnover, small) for which we expect the catering effect on intangible investment to be strongest. The stronger indirect effect among such firms suggests that the equity channel tends to reinforce the effect of catering.

A previous literature tests whether market valuations affect investment by examining whether stock prices have incremental predictive power above and beyond proxies for the quality of growth opportunities such as cash flow or firm profitability (Barro (1990), Blanchard, Rhee, and Summers (1993), Morck, Shleifer, and Vishny (1990), and Welch and Wessels (2000)). Bhagat and Welch (1995) find a weak link between past returns and R&D expenditures among U.S. firms. Such tests do not clearly distinguish the q theory of investment from the misvaluation hypothesis, since, even after controlling for profits, stock prices (or past returns) can reflect investment opportunities.

More recent papers have used indirect approaches to test for the effects of misvaluation on investment. One approach is to examine whether tight financial constraints make investment more sensitive to firm value. Motivated by an extension of the model of Stein (1996), Baker, Stein, and Wurgler (2003) find, consistent with their model, that the investment of financially constrained, or 'equity-dependent' firms is more sensitive to stock prices than that of firms that are not financially constrained.

This evidence is consistent with the idea that misvaluation affects investment more when the only effective way to fund investment is to raise new equity capital. However, Baker et al's misvaluation measure, Tobin's q, is also a measure of prospects for profit growth. Thus, an alternative interpretation of this evidence that better profit growth prospects increase investment more among financially constrained firms.[9]

Another approach to testing the misvaluation hypothesis is to relate investment to variables that are expected to correlate with misvaluation, such as discretionary accruals (Polk and Sapienza (2006)), and dispersion in analyst forecasts of earnings (Gilchrist, Himmelberg, and Huberman (2005)). These papers provide several findings consistent with misvaluation effects.[10] The intuitions for these variables as misvaluation proxies are appealing.[11] However, such tests are still indirect in the sense that they focus upon particular hypothesized correlates of misvaluation, rather than trying to measure directly the overall misvaluation of the firm's equity.[12]

[9]Baker, Stein, and Wurgler discuss how strong profit growth prospects can mitigate adverse selection problems with the funding of investments. Similarly, strong profit growth prospects mitigate debt overhang problems by increasing the expected payoff to providers of new equity.

[10]Polk and Sapienza find that discretionary accruals are positively related to investment and that this effect is stronger among firms with higher R&D intensity (which are presumably harder to value correctly), and among firms that have high share turnover (a measure of the degree to which current shareholders have short time horizons). This suggests that managers invest in order to boost the short-term stock price, a 'catering' policy. Polk and Sapienza also find (see also Titman, Wei, and Xie (2004)) that capital expenditures negatively predict returns, consistent with high-investment firms being overvalued. Gilchrist, Himmelberg, and Huberman (2005) find that greater dispersion in analyst forecasts of earnings is associated with higher aggregate equity issuance and capital expenditures.

[11]Discretionary accruals are hypothesized to be related to misvaluation because investors fail to distinguish between cash flows and accounting adjustments to earnings. Dispersion of analyst forecasts is hypothesized to correlate with investment because optimistic investors buy the stock but pessimists fail to sell short. Some authors, however, have argued that the ability of these variables to predict returns reflects rational risk effects.

[12]For example, sometimes investors may be in agreement in overvaluing a firm. Such overvaluation would not be captured by a dispersion of analyst forecast measure. Similarly, a firm can be misvalued even when there is no active attempt by managers to manipulate earnings, and misvaluation can vary for reasons other than variations in current earnings (as affected by accruals). These considerations suggest that it is useful to test the misvaluation hypothesis using a more inclusive measure of misvaluation.

2 Data and Methodology

Our initial data sample includes all U.S. firms listed on NYSE, AMEX, or NASDAQ that are covered by CRSP and COMPUSTAT during 1966 to 2005. The residual income model value to price (V/P) ratio also requires that firms be covered by I/B/E/S for earnings forecasts data, in addition to possessing the necessary accounting items. We further require each valid firm-year observation to have at least one of capital expenditures and R&D expenditures non-missing. Consequently, our sample starts from 1977 and ends 2005, including 57,223 firm-year observations. Finally, we exclude financial firms (firms with one-digit SIC of six). Our main sample (the "full sample") has a total of 53,354 firm-year observations between 1977 and 2005.

We examine the relation between firm investment levels (capital expenditures and R&D expenses) and the (mis)valuation level of the firm's equity (our misvaluation measures, B/P and V/P, are described below). We relate the firms' investment during each fiscal year to the firms' misvaluation measure that is calculated at the beginning of the fiscal year. For example, for a firm with December fiscal year end, we relate the misvaluation measure calculated at the end of December 2003 to the investment level for fiscal year ending in December 2004.

Our sample includes firms with different fiscal year-ends. To line up firms in calendar time for the cross-sectional analysis, we use June as the cut-off. We allow for a four-month gap from the fiscal year end for the accounting data to be publicly available. Under this timing convention, for calendar year t, we include firms with fiscal year ends no later than February of year t, and no earlier than March of year $t-1$. Note, therefore, that for the majority of firms, the investment expenditures actually occur one calendar year prior. For example, for year 2005, the investment expenditures for firms with December fiscal year end (the majority of firms) actually occur between January and December of 2004, and the misvaluation measure is calculated in December 2003. We compare the investment levels cross-sectionally among sample firms each year, and aggregate the comparison results across time.

2.1 Investment and Control Variables

We measure firms' investment activities using the following accounting data from COMPUSTAT annual files: capital expenditures [Item 128] and Research and Development expenditures [Item 46]. Our investment variables, $CAPX$, RD, and $TOTINV(CAPX+$

RD), are scaled by previous year total assets [Item 6].[13] As in previous studies on investment and valuation, all variables, include the ones described below, are winsorized at the 1st and 99th percentile to mitigate the influence of outliers. Panel A of Table 1 reports summary statistics of the investment variables. We do not delete a firm-year observation simply because a certain variable is missing. For example, there are about 60% as many RD observations as $CAPX$, and we do not delete $CAPX$ for a certain year simply because RD is missing for that year.

In the multivariate tests, we examine how investment levels depend on valuation measures, B/P and V/P, controlling for other investment determinants. These control variables include cash flow [Item 14 + Item 18 + RD] scaled by lagged assets (missing RD is set to zero in the cash flow calculation), and Tobin's q, defined as the market value of equity plus assets minus the book value of equity [Item 60 + Item 74] all over assets (see, e.g., Kaplan and Zingales (1997), Baker, Stein, and Wurgler (2003), and Polk and Sapienza (2006)). In addition, we include leverage (LEV) defined as (Item 9 + Item 34)/(Item 9 + Item 34 + Item 216), equity issuance defined as the change in book equity minus the change in retained earnings (ΔItem 60 + ΔItem 74 $-\Delta$Item 36) scaled by lagged assets, following the definition in Baker, Stein, and Wurgler (2003), and (to control for firm riskiness) monthly return volatility ($SIGMA$) estimated over the previous five years or at least two years due to missing observations. Except for cash flow and equity issuance, which are measured over the fiscal year, all control variables are measured at the start of the fiscal year. Table 1, Panel B presents summary statistics of these control variables.

2.2 Motivation for and Calculation of Mispricing Proxies

The reliability of the inferences we draw about the misvaluation hypothesis of corporate investment rests upon the quality of our misvaluation proxies, B/P and primarily V/P. The validity of our approach, however, does *not* require that either book value or residual income value be a better proxy for rational fundamental value than market price. We merely require that these measures contain substantial incremental information about fundamentals above and beyond market price. We would expect them to do so if a significant portion of variations in market price derives from misvaluation.

[13]Some studies use net plant, property, and equipment (PP&E) as well as total assets scalings. However, this paper includes non-manufacturing firms for which intangible assets are especially important, and compares the effects of misvaluation on the creation of intangible assets through R&D with the effect on tangible asset creation through capital expenditures. A scaling that reflects both kinds of assets seems most appropriate for this purpose.

In support of the B/P proxy, an extensive literature finds that firms' B/P ratios are remarkably strong and robust predictors of the cross-section of subsequent one-month returns (see, e.g., the review of Daniel, Hirshleifer, and Teoh (2002)). Psychology-based theoretical models imply that B/P is a proxy for misvaluation, and thereby will predict subsequent abnormal returns (see, e.g., Barberis and Huang (2001) and Daniel, Hirshleifer, and Subrahmanyam (2001)). Market values reflect both mispricing, risk, and differences in true unconditional expected cash flows (or scale). Book value can help filter out irrelevant scale differences, and so B/P can provide a less noisy measure of mispricing (see Daniel, Hirshleifer, and Subrahmanyam (2001)). On the other hand, B/P is a natural proxy for risk as well. An active debate remains about the extent to which B/P-based return predictability reflects a rational risk premium or correction of mispricing.[14]

The association of B/P with subsequent abnormal returns suggests that there is a misvaluation or risk component to the variation of B/P. However, B/P has been used as a proxy not just for misvaluation or for risk, but also for growth opportunities and for the degree of information asymmetry (Martin (1996)). Furthermore, proxies for Tobin's q that are highly correlated with B/P have been employed to measure the quality of corporate growth opportunities and the degree of managerial discipline. A further source of noise in B/P for our purposes is that book value, the numerator of B/P, is influenced by firm and industry differences in accounting methods.

We calculate B/P as a ratio of equity rather than total asset values, because it is equity rather than total misvaluation that is likely to matter for corporate investment decisions; a similar point applies for V/P. This would be the case, for example, for a firm with overvalued stock to raise equity rather than debt capital to finance an investment project.

There is also strong support for V/P as an indicator of mispricing. Lee, Myers, and Swaminathan (1999) find that aggregate residual income values predict one-month-ahead returns on the Dow 30 stocks better than aggregate B/P. Frankel and Lee (1998) find that V is a better predictor than book value of the cross-section of contemporaneous stock prices, and that V/P is a predictor of the one-year-ahead cross-section of returns. Furthermore, Ali, Hwang, and Trombley (2003) report that the abnormal returns associated with high V/P are partially concentrated around subsequent earnings

[14]See, e.g., Fama and French (1996) and Daniel and Titman (1997), and the review of Daniel, Hirshleifer, and Teoh (2002). Some more recent empirical papers addressing factor risk versus mispricing as explanations for the B/P premium include Griffin and Lemmon (2002), Cohen, Polk, and Vuolteenaho (2003) and Vassalou and Xing (2004).

announcements. They also report that after controlling for a large set of possible risk factors (including beta, size, book/market, residual risk, and loadings from the Fama and French (1996) three-factor model), V/P continues to predict future returns significantly. These findings make V/P an attractive index of mispricing.[15]

There are other possible indices of misvaluation. An alternative measure which we do not examine is the earnings/price ratio. Earnings price ratios have several drawbacks for our purposes. First, earnings/price is not as strong a predictor of month-ahead stock returns as book/market (see, e.g., Fama and French (1996)), suggesting that it is a less accurate measure of mispricing. Second, short-term earnings fluctuations will tend to shift earnings/price even if the degree of misvaluation is unchanged. Third, and relatedly, negative earnings are more common than negative book values, leading more frequently to negative values of earnings/price.

The residual income value has at least two important advantages over book value as a fundamental measure. First, it is designed to be invariant to accounting treatments (to the extent that the 'clean surplus' accounting identity obtains; see Ohlson (1995)), making V/P less sensitive to such choices. Second, in addition to the backward-looking information contained in book value, it also reflects analyst forecasts of future earnings.

Of course, it is possible that in the process of filtering out extraneous information, some genuine information about mispricing is also filtered out from V/P. In our sample, the correlation of B/P with V/P is fairly low, 0.185. Thus, V/P potentially offers useful independent information beyond B/P regarding misvaluation. This is to be expected, as much of the variation in book/market arises from differences in growth prospects or in managerial discipline that do not necessarily correspond to misvaluation.

Turning to procedure, we calculate the B/P proxy as the ratio of book value of equity to market value of equity. Each month for each stock, book equity (Item 60) is measured at the end of the prior fiscal year.[16] Market value of equity is measured at the end of the month.

Our estimation procedure for V/P is similar to that of Lee, Myers, and Swaminathan (1999). For each stock in month t, we estimate the residual income model (RIM) price, denoted by $V(t)$. With the assumption of "clean surplus" accounting, which states that

[15]For example, D'Mello and Shroff (2000) apply V/P to measure mispricing of equity repurchasers. As in Dong et al. (2006), our focus is on measuring market pricing errors relative to publicly available information. We therefore calculate our misvaluation proxies solely using contemporaneous information (current price, book value, and analyst forecasts).

[16]Using the definition as in Baker and Wurgler (2002) for book equity value does not change our results materially but reduces our sample size.

the change in book value of equity equals earnings minus dividends, the intrinsic value of firm stock can be written as the book value plus the discounted value of an infinite sum of expected residual incomes (see Ohlson (1995)),

$$V(t) = B(t) + \sum_{i=1}^{\infty} \frac{E_t[\{ROE(t+i) - r_e(t)\}\ B(t+i-1)]}{[1+r_e(t)]^i},$$

where E_t is the expectations operator, $B(t)$ is the book value of equity at time t (negative $B(t)$ observations are deleted), $ROE(t+i)$ is the return on equity for period $t+i$, and $r_e(t)$ is the firm's annualized cost of equity capital.

For practical purposes, the above infinite sum needs to be replaced by a finite series of $T-1$ periods, plus an estimate of the terminal value beyond period T. This terminal value is estimated by viewing the period T residual income as a perpetuity. Lee, Myers, and Swaminathan (1999) report that the quality of their $V(t)$ estimates was not sensitive to the choice of the forecast horizon beyond three years. The residual income valuations are also likely to be less sensitive to errors in terminal value estimates than in a dividend discounting model; pre-terminal values include book value, so that terminal values are based on residual earnings rather than full earnings (or dividends).[17] Of course, the residual income $V(t)$ cannot perfectly capture growth, so our misvaluation proxy V/P does not perfectly filter out growth effects. However, since V reflects forward-looking earnings forecasts, a large portion of the growth effects contained in B/P should be filtered out of V/P.

We use a three-period forecast horizon:

$$\begin{aligned} V(t) \;&=\; B(t) + \frac{[f^{ROE}(t+1) - r_e(t)]\, B(t)}{1+r_e(t)} + \frac{[f^{ROE}(t+2) - r_e(t)]\, B(t+1)}{[1+r_e(t)]^2} \\ &\quad + \frac{[f^{ROE}(t+3) - r_e(t)]\, B(t+2)}{[1+r_e(t)]^2\, r_e(t)}, \end{aligned} \tag{1}$$

where $f^{ROE}(t+i)$ is the forecasted return on equity for period $t+i$, the length of a period is one year, and where the last term discounts the period $t+3$ residual income as a perpetuity.[18]

[17] For example, D'Mello and Shroff (2000) found that in their sample of repurchasing firms, firms' terminal value was on average 11% of their total residual income value, whereas using a dividend discount model the terminal value was 58% of total value.

[18] Following Lee, Myers, and Swaminathan (1999) and D'Mello and Shroff (2000), in calculating the terminal value component of V we assume that expected residual earnings remain constant after year 3, so that the discount rate for the perpetuity is the firm's cost of equity capital.

Forecasted ROE's are computed as

$$f^{ROE}(t+i) = \frac{f^{EPS}(t+i)}{\bar{B}(t+i-1)}, \quad \text{where} \quad \bar{B}(t+i-1) \equiv \frac{B(t+i-1)+B(t+i-2)}{2},$$

and where $f^{EPS}(t+i)$ is the forecasted EPS for period $t+i$.[19] We require that each of these f^{ROE}'s be less than 1.

Future book values of equity are computed as

$$B(t+i) = B(t+i-1) + (1-k)\, f^{EPS}(t+i),$$

where k is the dividend payout ratio determined by

$$k = \frac{D(t)}{EPS(t)},$$

and $D(t)$ and $EPS(t)$ are respectively the dividend and EPS for period t. Following Lee, Myers, and Swaminathan (1999), if $k < 0$ (owing to negative EPS), we divide dividends by (0.06 $\times$ total assets) to derive an estimate of the payout ratio, i.e., we assume that earnings are on average 6% of total assets. Observations in which the computed k is greater than 1 are deleted from the study.

The annualized cost of equity, $r_e(t)$, is determined as a firm-specific rate using the CAPM, where the time-t beta is estimated using the trailing five years (or, if there is not enough data, at least two years) of monthly return data. The market risk premium assumed in the CAPM is the average annual premium over the riskfree rate for the CRSP value-weighted index over the preceding 30 years. Any estimate of the CAPM cost of capital that is outside the range of 3%-30% (less than 1% of our estimates) is winsorized to lie at the border of the range. Previous studies have reported that the predictive ability of V/P was robust to the cost of capital model used (Lee, Myers, and Swaminathan (1999)) and to whether the discount rate was allowed to vary across firms (D'Mello and Shroff (2000)). We checked the robustness of our main findings using the alternative constant discount rate of 12.5% (following D'Mello and Shroff (2000)). The results were similar to those reported here.

The benchmark for fair valuation is not equal to 1 for either ratio, for two reasons. First, book is an historical value that does not reflect growth. Second, residual income

[19] If the EPS forecast for any horizon is not available, it is substituted by the EPS forecast for the previous horizon and compounded at the long-term growth rate (as provided by I/B/E/S). If the long-term growth rate is not available from I/B/E/S, the EPS forecast for the first preceding available horizon is used as a surrogate for $f^{EPS}(t+i)$.

model valuations have been found to be too low on average. Thus, our tests consider relative comparisons these misvaluation proxies: higher (lower) values of B/P or V/P indicate relative undervaluation (overvaluation).

Panel C of Table 1 reports summary statistics the two valuation ratios. We retain negative V values caused by low earnings forecasts, because such cases should also be informative about overvaluation. We use V/P as a measure of undervaluation (rather than P/V as a measure of overvaluation), because negative values of P/V should indicate over- rather than under- valuation. For consistency we also use B/P rather than P/B. Removing negative V/P observations (about 5% of the sample) tends to reduce statistical significance levels in our tests without materially altering the results.

2.3 Conditioning Variables

Previous research has documented that proxies for the degree of financial constraints and the degree of investor short-termism affect the relationship between misvaluation and capital expenditures. As discussed in the introduction, there is theoretical motivation for such tests. Here we offer tests for these effects using an overall contemporaneous measure of misvaluation, V/P, that is purified of growth effects. The first conditioning variables we examine is the KZ index, as defined in Kaplan and Zingales (1997), a measure of financial constraints. Baker, Stein, and Wurgler (2003) show that corporate investment should be more sensitive to stock valuation level in financially constrained firms (high KZ index). Following Lamont, Polk, and Saa-Requejo (2001) and Baker, Stein, and Wurgler (2003), the original KZ index for year t is defined as

$$KZ_t(five\ variable) = -1.002CF_t - 39.368DIV_t - 1.315C_t + 3.139LEV_t + 0.283q_t,$$

where CF_t is cash flow scaled by lagged total assets; DIV_t is cash dividends (Item 21 + Item 19) scaled by lagged assets; C_t is cash balances (Item 1) scaled by lagged assets; LEV_t is leverage ((Item 9 + Item 34)/(Item 9 +Item 34 + Item 216)), and q_t is Tobin's q as defined earlier.

Since q contains market price, it should be correlated with market misvaluation, and has been used as a misvaluation proxy in past literature. To avoid using a conditioning variable for financial constraint that contains the misvaluation effects we are testing for, following Baker, Stein, and Wurgler (2003) we construct a four-variable version of the KZ index (excluding q) for year t:

$$KZ_t = -1.002CF_t - 39.368DIV_t - 1.315C_t + 3.139LEV_t.$$

Second, Polk and Sapienza (2006) examine a catering theory that the investment sensitivity to misvaluation will be higher when there is a higher fraction of short-term investors. They document that the sensitivity of capital expenditures to misvaluation is higher for stocks with high share turnover (here, measured as monthly trading volume as a percentage of total number of shares outstanding).[20]

Third, firm size, as measured by total assets, is a natural conditioning variable relating to multiple effects. Small firms may be more prone to market misvaluation than large firms because of greater uncertainty and information asymmetry between investors and insiders, and lower liquidity. Small firms also tend to have less access to external capital.

Panel D of Table 1 reports summary statistics of the conditioning variables that potentially influence valuation-sensitivity. These three variables are not highly correlated with each other, with the highest correlation being only 0.052 (between the KZ index and total assets). In the tests to follow, we examine how market valuations affect capital expenditures and R&D investment in the full sample, as well as in subsamples formed based upon these variables.

2.4 Time Patterns in Investment and Valuations

Table 2 reports yearly descriptive information for our sample during 1977-2005. Capital expenditures are relatively stable over time, but there is a marked decrease after 2001, suggesting that companies generally cut capital spending after the burst of the stock market bubble. This decrease in $CAPX$ is coupled with a drastic drop in cash flow in 2002. R&D activities, on the other hand, have wider variations but generally increase over time, and decline slightly after 2001. As mentioned in the introduction, after 1994, RD overtakes $CAPX$ as the larger component of corporate investment, growing much larger toward the end of the sample period. These facts emphasize the importance of examining RD in addition to $CAPX$.

Table 2 also shows that overall, V/P is higher than B/P, suggesting, as expected, that residual earnings add value to stocks on average. The V/P mean (median) of 0.733 (0.628) is substantially greater than the B/P mean (median) of 0.669 (0.515). V/P has a higher mean than B/P each year after 1993, except for the year 2002; V/P has a

[20] It has been suggested that the trading volumes in NASDAQ and NYSE/AMEX may not be directly comparable. Our conclusions with respect to share turnover are qualitatively unchanged when, following LaPlante and Muscarella (1997), we divide the NASDAQ trading volume by a factor of 2, or when we separate the NASDAQ and NYSE/AMEX listed firms in the tests.

higher median value each year after 1986.

3 How Misvaluation Affects Investment: Univariate Tests

This section provides univariate tests of the effect of misvaluation on tangible and intangible corporate investment. Each year, firms are grouped into quintile portfolios according to either B/P or V/P of the month preceding each fiscal year start. The valuation portfolios are formed annually to ensure that any effects we identify are cross-sectional, and therefore not driven by time-series swings in market valuation and investment activities. Each year mean investment levels are computed for each quintile. Finally, time-series mean of the investment levels for each quintile is computed.

Table 3 reports how under- or over- valuation is related to the capital expenditures and R&D activities. Mean values of B/P or V/P, and the investment variables $CAPX$, RD, the sum of the two investments ($TOTINV$), and their differences between top and bottom valuation firms are reported.

3.1 Full Sample Tests

We begin by examining the relation of investment to misvaluation in the full sample. Table 3 reports the relation of investment measures to B/P and V/P quintiles. It is evident that high-valuation firms (as measured by either B/P or V/P) invest more in both capital spending and R&D. Investment levels ($CAPX$, RD, and $TOTINV$) all increase monotonically with valuations; the most overvalued quintile measured by B/P (V/P) invests 11.51% (10.58%) more in total investment (capital expenditures and R&D) than the most undervalued quintile. All these quintile differences are highly statistically significant, with t-statistics all exceeding 4.64. The B/P evidence could reflect either misvaluation, or (under the rational q theory) that firms with strong growth opportunities invest more. The results using our purified misvaluation measure (V/P) strongly confirm that misvaluation affects corporate investment.

Furthermore, the evidence strongly supports the further implication of the misvaluation hypothesis, that intangible investment is more sensitive to misvaluation than tangible investment. RD is more sensitive to misvaluation as measured by V/P than $CAPX$. The most overvalued V/P quintile invests 8.30% more in RD, but only 2.12% more in $CAPX$, than the most undervalued quintile. In the full sample, the misvaluation sensitivity ratio (the ratio of interquintile spread of investment to the spread in valuation) for *RD* is 5.32, whereas the misvaluation sensitivity ratio for *CAPX* is only 2.12.

These findings highlight two immediate insights from tests using the purified V/P misvaluation measure as compared with B/P. First, R&D is much more sensitive to measured misvaluation than is evident using B/P. In the full sample, the difference in *RD* between the most over- and undervalued quintiles using V/P, is 8.30%, is larger than the 5.54% using B/P, and the misvaluation sensitivity ratio for *RD* using V/P of 5.32, exceeds that of B/P, 4.25.

Second, capital spending as measured by *CAPX* is much *less* sensitive to measured misvaluation than is evident using B/P. The difference in *CAPX* between the most over- and undervalued quintiles of 2.12% using V/P is much less than the 6.18% difference using B/P. Thus, the misvaluation sensitivity ratio for *CAPX* using V/P of 2.12 is far lower than the *CAPX* sensitivity ratio of 4.53 for B/P.

Thus, V/P provides a sharply different conclusion about the relative sensitivity to misvaluation of tangible versus intangible investments. Using B/P one would conclude that tangible investment, *CAPX*, has slightly higher sensitivity to misvaluation than does intangible investment, measure *RD* ($4.53 > 4.25$). However, this conclusion seems to come from the fact that B/P contains information about growth prospects, rather than from misvaluation effects. Using V/P, intangible investment is far more sensitive to misvaluation (*RD* sensitivity to V/P is 5.32 than is tangible investment (*CAPX* sensitivity to V/P is only 2.12).

As discussed in Section 2.2, V/P is a purer measure of misvaluation than B/P, because B/P reflects earnings growth prospects. So a natural explanation for the difference between the B/P and V/P findings is that growth has an effect opposing the misvaluation effect. For example, firms whose earnings are currently growing rapidly (as reflected in low B/P) are likely to have stronger prospects for growth through expansion of current assets, and hence are more likely to scale up current assets through heavier tangible investment.

3.2 Conditions Affecting the Sensitivity of Investment to Misvaluation

We now examine subsamples to test different possible reasons why misvaluation affects investment. Previous research has suggested that misvaluation should affect investment more among firms that are financially constrained (Baker, Stein, and Wurgler (2003)), and that the effect of misvaluation on investment should be stronger when investors have shorter time horizons (Polk and Sapienza (2006)). We form subsamples based upon the Kaplan and Zingales index, and based upon turnover, to test these theories. These tests differ from those in Baker, Stein, and Wurgler (2003) in our use of a misvaluation measure that focuses on equity rather than total firm misvaluation, and which is purified of earnings growth effects. Our tests differ from those in Polk and Sapienza (2006) in using an overall misvaluation measure (i.e., a deviation of price from a measure of fundamental value), rather than proxies for particular sources of misvaluation, such as the level of accruals.

Furthermore, our tests differ from previous literature in examining separately the effects of misvaluation on tangible versus intangible investment, and in considering conditionings based upon misvaluation categories. We will see that these differences offer further insights about why some firms may find it hard to take advantage of equity overvaluation.

Finally, we investigate whether there are systematic differences in the misvaluation effects on investment between large and small firms. We form size portfolios based upon total assets.

3.2.1 How Financial Constraints Affect the Sensitivity of Investment to Misvaluation

We first test the effects of misvaluation on investment among firms that are more versus less financially constrained, as measured by high versus low levels of the KZ index. According to the theory of Stein (1996) as extended by Baker, Stein, and Wurgler (2003), financially constrained firms should be more equity-dependent, and therefore possess high investment sensitivity to market valuation. This theory is confirmed in Baker, Stein, and Wurgler (2003) using q as a valuation measure and the KZ index as a measure of financial distress. Table 4 presents our univariate findings, where high financial constraints are identified as firms with above-median KZ index, and low constraints with below-median KZ index.

For B/P, the univariate evidence fails to support a difference in misvaluation sensitivities between sets of firms with different financial constraints. For $CAPX$, the inter-quintile B/P spread is -1.61 among high KZ index firms, and only -1.09 among low KZ-index firms. In the high-KZ subsample (Panel A), the most highly valued firms invest 7.61% more in capital expenditures than the lowest valuation firms; the ratio of this difference in capital expenditures to the difference in B/P is 4.72. In the low-KZ subsample (Panel B), the most highly valued firms invest 4.69% more in capital expenditures than the lowest valuation firms; the ratio of this difference in capital expenditures to the difference in B/P is 4.47. The two investment sensitivities (4.72 and 4.47) are therefore only minimally different, and Panel C indicates no significant difference in these sensitivities.

For RD, the inter-quintile difference in RD is identical among high-KZ and low-KZ firms (4.65%). Since the B/P spread is smaller among low-KZ firms, this means that investment is more sensitive to B/P among the low-KZ, financially *unconstrained* firms. Specifically, the sensitivity ratio among high-KZ firms is only 3.12, whereas the sensitivity ratio among low-KZ firms is a far larger 4.52. Panel C indicates that this difference in sensitivities is highly significant ($t = -3.70$).

For $TOTINV$, the sum of $CAPX$ and RD, the difference between the top and bottom valuation firms is higher among the high-KZ firms (11.40%) than among low-KZ firms (9.46%). However, since the B/P valuation spread is smaller among the low-KZ firms, the sensitivity of $TOTINV$ to B/P, 9.14, is actually greater than the sensitivity among the high-KZ firms, 7.28. Panel C indicates that this difference is significant ($t = -3.61$). Overall, the B/P evidence is not consistent with the theory.

However, B/P mixes misvaluation effects with growth effects, whereas the theory of Baker, Stein, and Wurgler is focused on the sensitivity of investment to misvaluation. Indeed, when valuations are measured by V/P, the findings for capital expenditures are quite different. We find reasonably supportive evidence for the model prediction for $CAPX$– more financially constrained firms seem to have higher sensitivities to misvaluation. Interestingly, for RD and for total investment ($TOTINV$), the pattern is reversed—more financially constrained firms have *lower* sensitivities of RD to misvaluation.

In Panel A, for the high-KZ subsample, the most overvalued firms (based on V/P) have substantially higher $CAPX$, 2.53%, than the most undervalued firms. This difference corresponds to a misvaluation sensitivity ratio for $CAPX$ of 2.25. In Panel B, the corresponding quintile difference in $CAPX$ for low-KZ firms is only 1.39%, though this difference is still highly statistically significant ($t = 3.16$). This difference corresponds to a misvaluation sensitivity ratio of 1.74. This point estimate is indeed lower than the estimated sensitivity for the high-KZ subsample, although Panel C indicates that the difference is only marginally significant ($t = 1.89$).

In contrast, the V/P evidence for R&D shows a much lower RD sensitivity to misvaluation among high than among low-KZ firms. In the high-KZ subsample (Panel A), the most overvalued quintile invests 5.05% more in R&D than the most undervalued quintile, which corresponds to a misvaluation sensitivity ratio of 3.25. For the low-KZ Subsample (Panel B), the most overvalued quintile invests 8.87% more in R&D than the most undervalued quintile, which corresponds to a far larger misvaluation sensitivity ratio of 6.35. Panel C indicates that the difference in sensitivities is highly significant ($t = -7.80$).

Furthermore, high-KZ firms also have lower sensitivity of overall investment ($TOTINV$) to V/P than do low-KZ firms. For instance, in the high-KZ subsample, overvalued firms invest 7.59% more than undervalued firms, for a misvaluation sensitivity ratio of 5.52. The corresponding $TOTINV$ difference among the low-KZ subsample is 10.62%, for a much higher misvaluation sensitivity of 8.32. Panel C indicates that the difference in sensitivities is highly significant ($t = -5.16$).

In summary, using our preferred measure of misvaluation (V/P), the univariate evidence provides support for the Baker, Stein, and Wurgler (2003) financial constraints theory as applied to tangible investments (capital expenditures); but for intangible investment (R&D), investment sensitivity is much stronger for firms that are financially *unconstrained*. Why are findings for intangible investments so strong and so different from the results for tangible investments? A possible explanation is that financial distress affects differently a firm's ability to exploit misvaluation through tangible versus intangible investment. Distress may interfere with the creation of intangible assets, since customers, employees and suppliers may be reluctant to commit to firm-specific investments, such as the time and effort required to build relationships with the firm (see, e.g., Titman (1984)). In other words, the firm may face reluctance on the part of parties, either within or outside the firm, whose inputs would be complementary with intangible investments by the firm. As a distressed firm becomes more overvalued (or less undervalued), it may not be able to usefully increase its investment in intangibles as easily as it can increase its investment in tangible assets.

3.2.2 How Investor Time Horizons Affect the Sensitivity of Investment to Misvaluation

Table 5 shows the univariate relationship between investment and valuation for subsamples sorted by share turnover. Polk and Sapienza (2006) hypothesize that high-turnover firms should have higher investment-valuation sensitivity because these firms have short-term investors. They also provide empirical support for this prediction using accruals as an indicator of misvaluation. Table 5 shows that this prediction is confirmed in the univariate test using an overall measure of misvaluation, V/P.

We begin with the findings for B/P, recognizing that this could reflect either misvaluation or growth effects. All three investment measures – $CAPX$, RD, and $TOTINV$, show a higher sensitivity to B/P in the high-turnover subsample than in the low-turnover subsample. For example, in the high-turnover subsample, the most highly valued quintile based on B/P invests 7.03% more in capital expenditures than the lowest value quintile, implying a valuation sensitivity of 5.21; the corresponding difference is 4.35% for the low-turnover subsample, for a valuation sensitivity of only 3.24. A similar point holds for R&D.

Using V/P, the most overvalued quintile invests 2.02% more in capital expenditures than the most undervalued quintile for a valuation sensitivity of 2.25; the corresponding difference is only 1.02% for the low-turnover subsample, for a valuation sensitivity of only 1.03. As in the full sample, R&D is more sensitive to valuation than capital expenditures. Furthermore, the difference in R&D sensitivity between the high- and low-turnover subsamples is greater than the difference in capital expenditures sensitivity.

3.2.3 How Firm Size Affects the Sensitivity of Investment to Misvaluation

Table 6 reports the univariate investment-valuation relations for subsamples sorted by total assets. When valuation is measured by B/P, small firms appear to have higher sensitivity of $CAPX$ to valuation than do large firms. The valuation sensitivity ratio of 5.13 for small firms is significantly higher than the sensitivity ratio of 3.87 for large firms ($t = 4.31$). However, using the purified measure V/P, the misvaluation sensitivity ratio for large firms is higher than that for small firms, though the difference, 0.36, is not significant ($t = 0.91$). This finding indicates that the difference in sensitivity of $CAPX$ to B/P between large and small firms derives from growth opportunities rather than misvaluation, i.e., that small firms have a higher sensitivity of $CAPX$ to growth opportunities than do large firms.

In contrast, small firms have higher sensitivity of R&D to misvaluation than large firms, sorting misvaluation by either B/P or V/P. Using B/P, the sensitivity of small firm RD to misvaluation is 1.99 higher than the sensitivity of large firms ($t = 4.31$); using V/P, this difference in valuation sensitivity between small and large firms is even higher (3.00; $t = 10.28$). In particular, among small firms, the most overvalued firms according to V/P invest 14.82% in R&D, more than triple the R&D of the most undervalued firms

(4.66%).

One of the possible reasons for a difference between large and small firms is that small firms have less access to equity capital. We therefore defer discussion of the explanation for the difference in findings for small versus large firms until Section 4, where we perform multivariate tests which decompose the effects of misvaluation into a direct effect and an effect that operates through equity issuance.

4 Multivariate Tests

Both to test the robustness of the investment-valuation relations documented in the previous section, and to evaluate whether misvaluation effects on investment operate through equity issuance, we perform multivariate analysis with additional controls, and tests that measure the strength of the equity issuance channel. The controls we use include Tobin's q, cash flow scaled by lagged assets, leverage, equity issuance scaled by lagged assets, return volatility, and 2-digit SIC major industry dummies as defined by Moskowitz and Grinblatt (1999).

Polk and Sapienza (2006) point out that in general equity issuance constitutes a relatively low fraction of the capital available to firms for capital investment. This provides a useful perspective on the finding that much of the misvaluation effect on investment does not operate through equity issuance. Nevertheless, the misvaluation hypothesis in general suggests that overvaluation should increase equity issuance and investment (Stein (1996), Baker, Stein, and Wurgler (2003), Gilchrist, Himmelberg, and Huberman (2005)), and as discussed in the introduction, there is evidence that equity issuance is associated with overvaluation. These past findings suggest that it is interesting to test whether misvaluation influences investment through the issuance of overvalued equity.

We perform Fama-MacBeth style regressions cross-sectionally each year, so that the B/P and V/P measures, as well as the investment variables, are compared cross-sectionally, in order to eliminate possible spurious effects arising from time-series swings in these variables. Table 7 reports the time-series weighted averages and t-statistics of the coefficients of the regressions for the full sample, where the weight is the number of firms in each yearly regression. The dependent variables are $CAPX$, RD, and $TOTINV$.

We report four regression specifications for each dependent variable. (1) We regress on B/P. (2) We regress on V/P. (3) We include both B/P and V/P (dropping q since q and B/P capture similar information) to examine whether there is incremental explanatory power from V/P as a misvaluation measure given B/P. If so, this provides a fairly stringent confirmation that the identified effect is a result of misvaluation, rather than the earnings growth fundamentals that are correlated with book/market. We draw our main inference from specification (3) which is more stringent as a test of the misvaluation hypothesis. (4) We add equity issuance as a further regressor to specification (3). We discuss model (4) primarily in Section 4.1.1 where we address equity financing as a channel through which misvaluation may affect corporate investment. There we also address the endogeneity of equity issuance using 2-stage least squares regressions.

4.1 Full Sample Tests

Table 7 presents regression results for the full sample. The coefficient of -0.479 ($t = -3.40$) on V/P in specification (2) indicates that V/P has a significant negative relation to $CAPX$ for the full sample—undervalued firms invest less. B/P is highly significant, so as a conservative test we additionally control for B/P in specifications (3) and (4). V/P remains significant both in regression (3), which omits equity issuance, and regression (4), which includes it.

The effect of misvaluation on R&D is impressive. The coefficient on V/P is highly significant in all specifications. In regression (3), which controls for B/P, V/P has a coefficient of -1.999 ($t = -7.89$). The coefficients on V/P in the R&D regressions are roughly 4 times greater than the coefficients in the $CAPX$ regressions. This is consistent with the univariate tests (Table 3) which show that RD has a much higher sensitivity to V/P than does $CAPX$. Finally, $TOTINV$ (the sum of $CAPX$ and RD) is also highly sensitive to V/P; the V/P coefficient in the $TOTINV$ specification (3) is -2.453 ($t = -8.36$).

A comparison of models (3) and (4) for each of the dependent variables shows that the coefficient on V/P decreases only modestly when the equity issuance variable EI is included. This is similar to the findings of Polk and Sapienza (2006) for $CAPX$ using discretionary accruals as a misvaluation proxy, and might seem to suggest that the equity channel explains little of the misvaluation effect. However, since equity issuance should be endogenously related to misvaluation, we later perform 2-stage least squares tests to address the effects of equity issuance.

To gauge the economic importance of the investment-valuation relation, we examine the effect of a one-standard-deviation shift in V/P on investment levels; and compare this to the effect of a comparable shift in cash flow. Table 1 shows that the standard deviations of V/P and cash flow are 0.672 and 13.65%, respectively (where cash flow is expressed as a percent of total assets). According to the *TOTINV* regression specification (3), a one-standard-deviation shift in V/P therefore implies a 1.65% (2.453×0.672) change in *TOTINV* (where investment is expressed as a percent of total assets.) This compares with a 4.16% (0.305×13.65) change in the investment ratio by a one-standard-deviation shift in cash flow, implying that the effect of valuation on corporate investment is about 40% of the effect of cash flow.

The sensitivities of *RD* to misvaluation and to cash flow are much closer. The corresponding sensitivities are 1.34% and 2.03% for one-standard-deviation shifts in V/P and cash flow, respectively.

4.1.1 The Equity Channel

There are theoretical arguments for why misvaluation should affect investment, either through equity issuance or directly for purposes of influencing the the current stock price (Stein (1996), Baker, Stein, and Wurgler (2003), Gilchrist, Himmelberg, and Huberman (2005), Jensen (2005), and Polk and Sapienza (2006)). Both theory and past evidence also suggest that equity issuance is endogenously related both to misvaluation and to our controls. To measure the extent to which the effect of misvaluation on investment operates through the equity channel, we therefore perform 2-stage least squares (2SLS) regressions.

Each year, 2SLS cross-sectional regressions are performed for model (4) in Table 7, with equity issuance (*EI*) being an endogenous variable. Specifically, the system of equations is as follows:

$$\begin{aligned} EI &= a_1 + b_1 V/P + c_1 B/P + d_1 CF + e_1 LEV + f_1 SIGMA + u_1 \\ S &= a_2 + b_2 V/P + c_2 B/P + d_2 CF + e_2 LEV + f_2 SIGMA + g_2 \widehat{EI} + u_2, \end{aligned}$$

where S is one of the investment variables $CAPX, RD$, or $TOTINV$. The first-stage EI regression includes 2-digit SIC major industry dummies in addition to the exogenous variables (V/P, B/P, CF, LEV, and $SIGMA$) in the independent variables. In the second-stage investment regression, the endogenous variable $\widehat{EI}$ is the predicted value of equity issuance from the first-stage regression.

Based on this structure, the coefficient of V/P in the second-stage S regression, b_2, reflects the direct effect of misvaluation on investment, because this is the effect of V/P after controlling for the effect of equity issuance. The indirect effect of V/P on investment through equity issuance is measured by $b_1 \times g_2$, the product of the coefficient of V/P in the first-stage EI regression and the coefficient of $\widehat{EI}$ in the second-stage S regression. Finally, the sum of direct and indirect effects, $b_2 + b_1 g_2$, measures the full effect of V/P on investment. It is also the V/P coefficient in the reduced form S regression. We calculate the time-series weighted averages and t-statistics of the direct, indirect, and full effects of V/P on investment, where the weight is the number of firms in each yearly regression.

The first bank of regressions in Table 8 shows the effect of misvaluation on capital expenditures through different channels. The equity issuance equation confirms evidence from previous studies (Loughran and Ritter (1995), Baker and Wurgler (2000), Baker, Stein, and Wurgler (2003), and Dong, Hirshleifer, and Teoh (2007)) suggesting that overvaluation is associated with greater equity issuance. The coefficient on V/P in the second regression shows that the direct effect of V/P on CAPX is small and insignificant. However, the coefficient of 0.165 ($t = 2.42$) on $\widehat{EI}$ indicates that the indirect effect of V/P on $CAPX$ through equity issuance is significant.

Nevertheless, in the reduced form equation for $CAPX$, the coefficient indicating the total effect of V/P on $CAPX$, -0.258 ($t = -1.43$) is insignificant. The subsample analysis below will show that there is a significant total effect of V/P on $CAPX$ among the most financially constrained firms, and among the most overvalued firms.

Overall, the findings for capital expenditures provide a degree of evidence that misvaluation affects capital expenditures through the equity channel, but little indication of a direct effect. However, we will later see that there are subsamples in which the direct catering effect is stronger than the equity channel effect.

The second bank of regressions show the effect of misvaluation on R&D occurring both through and independently of equity issuance. Again the equity issuance equation confirms that overvaluation increases equity issuance (the numbers are slightly different because of different data requirements for the R&D regression). In contrast with the $CAPX$ tests, the coefficient on V/P in the second regression shows that the direct effect of V/P on R&D (-1.002) is highly significant ($t = -4.28$). Furthermore, the coefficient of 0.438 ($t = 4.34$) on $\widehat{EI}$ indicates that the indirect effect of V/P on R&D through equity issuance is also highly significant. Not surprisingly given these results, in the reduced form equation for R&D, the coefficient indicating the total effect of V/P on R&D, -2.426 ($t = -8.40$) is highly significant.

Overall, the R&D findings provide strong evidence that misvaluation affects intangible investment both through the equity channel, and directly. This suggests that overvaluation encourages R&D both by reducing the firm's cost of capital, and by encouraging managers to cater in order to boost the short-term stock price. The stronger findings on catering incentives for R&D than for capital expenditures makes sense, because there is more room for overoptimistic investor perceptions about highly uncertain exploratory projects (R&D) than for more routine projects (capital expenditures).

The third bank of regressions show the effect of misvaluation on total investment (*TOTINV*) occurring through the different channels. As with the R&D tests, the evidence for *TOTINV* strongly support the conclusion that misvaluation affects investment both through the equity channel, and directly.

Specifically, out of the full effect of V/P on $TOTINV$ (-2.653), just -1.414, or 53.3%, comes from the direct effect. Thus, close to half of the total misvaluation effect occurs through catering, and half though the equity channel. In comparison with Table 7 which treated equity issuance as exogenous (see model (4)), we see that neglecting the endogeneity of equity issuance causes strong overestimation of the direct effect of V/P on investment, and severe underestimation of the strength of the equity channel.

4.2 Subsample Tests

Different versions of the misvaluation hypothesis offer interesting predictions about the sensitivity of investment to misvaluation in different subsamples of firms. We therefore perform several subsample tests.

One set of tests involves examining separately firms that are in different misvaluation quintiles. When a firm is undervalued, fixed costs of equity issuance may limit equity-financed investment. If undervalued firms issue less equity (see Loughran and Ritter (1995), Baker and Wurgler (2000), Baker, Stein, and Wurgler (2003), Dong, Hirshleifer, and Teoh (2007)), then a reduction in the undervaluation may not increase equity issuance and investment much. In contrast, if firms that are overvalued often issue equity, then an increase in overvaluation is likely to increase the scale of issuance and investment among issuers substantially. Similarly, if projects have a minimum technologically efficient scale, then a reduction in undervaluation may matter little for an inframarginal project that is being rejected anyway, whereas an increase in overvaluation is likely to increase the scale of the adopted project.

An alternative reasoning based upon catering potentially yields a similar implication. Managers of overvalued firms may be particularly anxious to undertake overvalued investments in order to satisfy investors' overly optimistic perceptions. The prevalence of such managerial behavior are discussed by Jensen (2005), who warns that such effects are likely to be found among overvalued firms.

Thus, arguments based upon the equity channel and based upon catering both imply that investment will be more sensitive to valuation among overvalued firms. We test these ideas by measuring the investment sensitivity to misvaluation within subsamples of firms sorted into misvaluation quintiles.

The main empirical prediction of Baker, Stein, and Wurgler (2003) is that the sensitivity of investment to misvaluation is strongest among equity-dependent firms. We test this by measuring investment sensitivities in subsamples sorted by the Kaplan/Zingales index. To test for the effect of investor time horizon upon catering incentives (Polk and Sapienza (2006)), we perform subsample tests sorting by turnover. Finally, we examine how the effects of misvaluation on investment vary with firm size.

The lower transparency and liquidity of small firms implies stronger misvaluation effects (see also footnote 24). However, if the cost of issuing equity for small firms is very high (so that even overvalued small firms seldom issue equity), limited access of small firms to equity markets can dampen the sensitivity of their equity-financed investment to misvaluation. Furthermore, the managers of small firms are likely to face stronger pressures to cater to investor beliefs than large firms, because small firms are likely to be held by a less sophisticated investor base (small investors), and are more subject to hostile acquisitions and delisting pressures than large firms when market valuations are low. Our tests provide separate measures for the direct (catering) and indirect (equity channel) sensitivity of investment to misvaluation. Thus, tests sorting by firm-size provide insight into the differing constraints and pressures faced by small versus large firms.

We report the subsample results in Tables 9-12, for each of the valuation, KZ, turnover, and size subsamples. For each subsample, Panels A, B, and C report the direct, indirect, and full effects of V/P on investment, respectively, based on the 2SLS regressions.[21]

4.2.1 Valuation-Subsample Regressions

Table 9 describes the relation between investment sensitivity to misvaluation level as measured by V/P among firms in different misvaluation categories. Using 2SLS estima-

[21]In unreported tests, we compare the OLS regressions in Table 7 models (3) and (4) to the 2SLS results for the subsamples. For all subsamples, OLS which does not consider the endogenous effect of equity issuance tends to overestimate the direct effect but underestimate the full effect of V/P on investment, as in the full sample test.

tion as in Section 4.1, it is evident that both the direct and indirect effect of V/P on investment are almost entirely among the top 2 misvaluation quintiles, with a statistically significant inter-quintile difference between the top and bottom valuation quintiles for all effects except for the indirect effect of V/P on $CAPX$. It is also clear that the misvaluation effect on RD is much stronger than $CAPX$, consistent with earlier evidence.

Furthermore, the direct effect of V/P on investment is stronger than the indirect (equity issuance) effect, for both $CAPX$ and RD. For $CAPX$, the indirect effect of V/P through the equity channel is nonexistent, even for the most overvalued quintile. The direct V/P effect, on the other hand, is significant among the top misvaluation quintile (-1.915; $t = -2.11$), with some indication of significant effect among quintile 2 (-3.056; $t = -1.85$).

For RD, the equity channel effect of V/P is significant only among the top valuation quintile (-3.901; $t = -3.30$). Although this indirect effect is highly significant economically and statistically, the direct effect is much stronger (-9.071; $t = -4.69$). This is what one would expect if the catering incentive is strongest when the firm is highly overvalued, as has been argued by Jensen (2005). A similar pattern exists for $TOTINV$.

Using 2SLS estimation as in Section 4.1, for the most overvalued quintile firms (using unreported subsample data for the most overvalued quintile), the economic impact of a one-standard-deviation shift in misvaluation on RD is 4.46%, exceeding the equivalent impact of a one-standard-deviation shift in cash flow (3.28%).

Finally, the full V/P effect as reported in Panel C indicates that misvaluation affects RD, $CAPX$, and total investment primarily among the top one or two overvaluation quintiles.

4.2.2 KZ-Subsample Regressions

Baker, Stein, and Wurgler (2003) provide evidence that financially constrained firms have greater sensitivity of investment to misvaluation. Our tests differ in two main ways. First, we examine equity B/P instead of total firm q, based on our argument that it is equity misvaluation that is most relevant for equity financing decisions. Second, we examine V/P, our misvaluation proxy that is purified of growth effects, along with tests that include B/P as an additional control for growth.

Table 10 shows that, consistent with the prediction of Baker, Stein, and Wurgler (2003), high-KZ firms have capital expenditures that are more sensitive to misvaluation (V/P) than low-KZ firms. In Panel C, we see that the full V/P effect on $CAPX$ is significant only for the highest-KZ quintile (-1.055; $t = -3.41$). The effect for the lowest-KZ quintile is nearly zero, and the difference in the full V/P effect on $CAPX$ between the two quintiles is statistically significant (-1.054; $t = -2.61$). This finding refines the univariate evidence and suggests that the effect of misvaluation on capital spending concentrates in firms with high degrees of financial constraints.

Among the highest-KZ firms, the V/P effect comes mostly from the direct effect (-0.777; $t = -2.56$ in Panel A); the indirect effect is only -0.278; $t = -2.00$ (Panel B), and the inter-quintile difference is significant only for the direct effect (-0.809; $t = -1.98$). This suggests that even for the highest-KZ firms, the equity channel is only part of the misvaluation effect on capital expenditures.

The relationships for R&D are stronger, and provide a sharp contrast. As with the univariate result, low-KZ firms have R&D that is highly sensitive to misvaluation as measured by V/P. Furthermore in the multivariate tests, the R&D of low-KZ firms is more sensitive to misvaluation than the R&D of high-KZ firms. In Panel C, the full effect of V/P for the lowest-KZ quintile is nearly quadruple that for the highest-KZ quintile, with a significant difference (2.881; $t = 4.69$). Moreover, both the direct and indirect effects of misvaluation on RD (in Panels A and B) are stronger among low-KZ firms. For example, the indirect V/P effect through the equity channel is stronger among low-KZ firms (-1.580; $t = -2.65$) than among high-KZ firms (insignificant).

Finally, consistent with the univariate evidence, high-KZ firms have total investment that is less sensitive to misvaluation than low-KZ firms. For example, the full V/P effect on $TOTINV$ for the lowest-KZ quintile is -4.302 ($t = -8.29$), more than double the effect among the highest-KZ quintile (-1.709; $t = -4.96$).

Thus, even more strongly than the univariate tests, the multivariate evidence supports the Baker, Stein, and Wurgler financial constraints theory as applied to tangible investments (capital expenditures). However, the multivariate tests also confirm strongly that other forces are operating when it comes to the relation between misvaluation and intangible investment (R&D).

Why is the R&D of unconstrained (low-KZ) firms especially sensitive to misvaluation? And why are the effects of financial constraints on misvaluation sensitivity so different for tangible versus intangible investment? A plausible explanation is that firms that are financially constrained are limited in their freedom to engage profitably in R&D because of the need for financial flexibility. One reason for this is that stakeholders such as employees, suppliers, or customers may be reluctant to commit to long-term relationships with a firm that is subject to distress, and the inputs of such stakeholders may be especially important for the success of investments designed to generate intangible assets. Furthermore, intangible investments generate real options, making it especially valuable for the firm to have the flexibility to spend heavily in the future. For example, firms with heavy R&D activity such as pharmaceutical firms tend to maintain low leverage ratios, presumably to maintain flexibility in investment. For firms that are more financially constrained, an increase in overvaluation may encourage equity issuance for purpose of investing in R&D relatively little compared to firms with low financial constraints. In other words, if the possibility of distress greatly reduces the expected profitability of a firm's intangible investment, greater overvaluation may do little to make such investment attractive.

4.2.3 Turnover-Quintile Regressions

Turning to the effects of investor time horizons on investment, Table 11 reports the misvaluation effects on investment for the turnover quintiles. Examining the full V/P effect, we see that high-turnover firms have higher sensitivity than low-turnover firms of R&D to misvaluation. However, this is not the case for $CAPX$, for which there seems to be no clear pattern in the V/P coefficient across the turnover quintiles. The direct V/P effect is not significant among any turnover quintile, and there is some indication of significant indirect effect among low-turnover firms. Thus, the univariate finding that high-turnover firms have higher sensitivity of $CAPX$ to misvaluation is not robust to controlling other investment determinants such as B/P and cash flow.[22]

R&D, on the other hand, is highly sensitive to V/P among both high and low turnover firms, with a much greater full V/P effect (-3.811; $t = -8.86$) for highest-turnover firms than for lowest-turnover firms (-1.813; $t = -6.08$). This higher sensitivity of RD to misvaluation comes more from the equity channel than from the direct effect. The indirect V/P effect is (-2.067; $t = -2.76$) for the highest turnover quintile, which is higher than that among lowest turnover firms (-0.657; $t = -2.74$) with a difference of -1.410 ($t = 1.95$). In contrast, the direct effect of V/P on RD is not monotonically related to turnover. For $TOTINV$, there is some evidence that the direct effect of VP

[22]Polk and Sapienza (2006) find that the relation between $CAPX$ and discretionary accruals, their proxy for misvaluation, is strongest for firms with high turnover. The lack of a clear trend in sensitivities across turnover quintiles using V/P may come from the conservative nature of V/P as a misvaluation proxy. Even though B/P is confounded by the effects of growth prospects, it does contain incremental information about misvaluation. In a test using B/P as a misvaluation proxy, the full effect of B/P on investment more than doubles moving from the lowest to the highest turnover quintiles. There are also some other differences between the sample and control variables in our investment regression and those of Polk and Sapienza's tests.

increases with turnover, though the relation is not monotonic.

The evidence that the indirect effect of V/P on R&D through the equity issuance is stronger among high turnover firms suggests that the equity channel acts to reinforce catering. Intuitively, if the market is over-enthusiastic about a firm's new investment projects, investors may expect the firm to raise equity capital to undertake them. Thus, the equity channel can be complementary with catering.

In sum, we find that there is strong evidence for catering with respect to R&D expenditures. Polk and Sapienza (2006) provide evidence for catering based upon the relation between discretionary accruals and capital expenditures being stronger among high turnover firms. We find that the relation of R&D to our overall measure of misvaluation, V/P, is also stronger among high turnover firms.

4.2.4 Size-Quintile Regressions

Table 12 reports the effect of V/P within quintiles sorted by total assets. Consistent with the univariate finding, for $CAPX$, there is no clear trend in the V/P effects across the size quintiles.[23]

Also consistent with the univariate test, small firms show a much higher sensitivity of RD to misvaluation than do large firms. For example, the full V/P effect on RD for the smallest-firm quintile is -4.097 ($t = -8.54$), more than five times the effect for the largest-firm quintile (-0.712; $t = -4.92$). Moreover, both direct and indirect effects of V/P on RD demonstrate the same strong trend with respect to size.

Why do small firms have higher sensitivity of R&D to misvaluation? First, small firms may be more prone to misvaluation because of lower availability of information to investors and lower liquidity.[24] Moreover, the opaqueness of small firms may apply especially strongly to R&D projects, implying a greater impact of misvaluation on R&D for small firms.

Since small firms have less access to external equity, the finding that the indirect effect of V/P on R&D (through the equity channel) is stronger for small firms suggests

[23]There is an interesting U-shaped relation between the indirect V/P effect on $CAPX$ and size. One interpretation may be related to financial constraints. Small firms tend to be constrained so the equity channel effect is expected to be larger; however, small firms may have limited access to external capital. Thus the misvaluation effect on capital expenditures through the equity channel can be strongest among mid-sized firms.

[24]To the extent that small firms are more prone to misvaluation, the signal-to-noise ratio for a misvaluation proxy should be higher among small firms, implying a stronger relation between measured misvaluation and investment.

that overvaluation helps firms that would otherwise not find it easy to raise equity capital to fund intangible projects.

Looking across the subsample analyses, we can summarize separately for tangible and for intangible investment the importance of direct and indirect effects of misvaluation. For capital expenditures, the indirect effect is strong only among financially constrained firms, consistent with the Baker, Stein, and Wurgler (2003) model. The direct effect is strong mainly among financially constrained firms, and among overvalued firms. The strength of the direct effect among overvalued firms is consistent with the hypothesis that catering incentives (the pressure to maintain a high stock price) are especially strong among overvalued firms (Jensen (2005)).

For R&D, the indirect (equity channel) effect of misvaluation is strongest among firms that are less financially constrained, and for the kinds of firms for which we expect the direct effect (catering) on intangible investment to be strongest—firms that are overvalued, have higher turnover, and are smaller. The fact that this indirect effect is stronger among such firms suggests that equity issuance in response to misvaluation tends to reinforce the effect of catering. As argued earlier, there is reason to expect the equity channel to be complementary with catering incentives.

5 Conclusion

We examine the relation between corporate investment— capital expenditures and R&D— and equity misvaluation as measured by book/price (B/P), or by the ratio of residual income valuation to price (V/P). We draw our main inferences using V/P, because V/P allows us to determine whether a relation between a market misvaluation proxy and corporate investment is due to the effects of mispricing rather than profit growth prospects.

We find, consistent with the misvaluation hypothesis, that capital expenditures and, very strongly, R&D, are positively related to the degree of overvaluation, after controlling for several other investment determinants. The stronger effect on R&D is consistent with the hypothesis that misvaluation effects are stronger for investments that are harder to value. We find that misvaluation affects investment both through the equity channel, and, consistent with Polk and Sapienza (2006), through direct catering. We confirm this in tests that address the fact that equity issuance endogenously depends upon misvaluation.

To further probe the economic sources of these effects, we examine whether the effects of misvaluation on capital expenditures and R&D differ in subsamples of firms in which the degree of misvaluation, the degree of financial constraint, the investor time horizon, or firm size differ. We discuss several reasons why misvaluation effects should be stronger among more overvalued firms, and find empirically that misvaluation affects investment only among the top one or two overvaluation quintiles.

We find that the capital expenditures of financially constrained firms (with high KZ index) are more sensitive to market misvaluation than that of non-distressed firms, consistent with the theory of Baker, Stein, and Wurgler (2003). In contrast, we find that the R&D expenditures of financially constrained firms are much *less* sensitive to market misvaluation than those of unconstrained firms. This finding presents an intriguing puzzle. We suggest that the explanation is that the benefits to exploiting overvaluation to finance intangible growth opportunities may be lower when financial constraints reduce flexibility and the willingness of stakeholders to provide complementary inputs.

In tests for the effect of investor time horizon, we find that the sensitivity of R&D, but not capital expenditures, to valuation is higher among high-turnover firms. This suggests that catering pressures to maintain short-term valuation are more relevant for intangible than for tangible investment, consistent with the hypothesis that intangible investments are more prone to being misvalued by investors.

Owing to the greater opaqueness and lower liquidity of small firms, small firms should be more prone to misvaluation than large firms, which suggests greater misvaluation effects on investment for small firms. For the equity channel, however, a potentially opposing effect is that large firms have greater access to equity markets than small firms. If overvaluation stimulates investment through equity issuance, the effect could be greater among large firms.

Empirically, we find that small firms do not have a higher sensitivity of capital expenditures to misvaluation than do large firms, but do have a much higher sensitivity of R&D to misvaluation in both the direct effect of misvaluation and through the equity channel. A possible explanation is that the pressure to cater is especially important for intangible investment and for small firms. (The greater sensitivity of R&D to misvaluation among small firms through the equity channel could be because equity issuance is complementary with such catering.)

We explore the conditions affecting the relative strength of the direct effect of misvaluation (catering in order to increase the current stock price) versus the indirect effect through equity issuance. For capital expenditures, the indirect effect is strong only among financially constrained firms, consistent with the Baker, Stein, and Wurgler (2003) model. The direct effect is strong mainly among financially constrained firms, and among overvalued firms. The strength of the direct effect among overvalued firms is consistent with the hypothesis that catering incentives are especially strong among overvalued firms (Jensen (2005)).

For R&D, the indirect (equity channel) effect of misvaluation is strongest among firms that are financially unconstrained, and for the kinds of firms for which we expect the direct effect (catering) on intangible investment to be strongest— firms that are overvalued, have higher turnover, and are smaller. The fact that this indirect effect is stronger among such firms suggests that equity issuance in response to misvaluation tends to reinforce the effect of catering. This is reasonable, since raising equity capital to invest should be complementary with the decision to invest to cater to optimistic investor expectations.

In sum, we find that there is strong evidence in favor of the misvaluation hypothesis using an overall measure of market misvaluation that filters out earnings growth prospects by using a forward-looking fundamental measure; the effects of misvaluation are very different for tangible and intangible investment; and that conditional tests provide further insight into the sources of misvaluation effects.

The evidence of strong misvaluation effects on investment in the cross-section raises the question of whether misvaluation drives aggregate patterns of corporate investment activity as well. As discussed in the introduction, the methods used in existing studies have not been able to resolve sharply whether the relation between stock prices and investment derives from rational effects or misvaluation. The use of an overall aggregate misvaluation proxy from which contaminating growth effects are removed, and the separate examination of tangible versus intangible investment, may help resolve whether and why misvaluation affects corporate investment in the macro-economy.

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Table 1. Summary Statistics of Investment, Valuation, and Control Variables

The sample includes U.S. non-financial firms listed on NYSE, AMEX and NASDAQ with COMPUSTAT and I/B/E/S coverage during 1977-2005. The investment variables include capital expenditures (*CAPX*), R&D expenditures (*RD*), and total investment expenditures (*TOTINV*) (sum of the two), all scaled by lagged assets for each fiscal year. *q* is Tobin's *q* ratio measured as market value of equity plus total assets minus book value of equity over total assets. *CF* is cash flow (Item 14 + Item 18 + *RD*) over the fiscal year scaled by lagged assets (missing *RD* is set to zero in the *CF* calculation). Leverage (*LEV*) is defined as (Item 9 + Item 34)/(Item 9 + Item 34 + Item 216). *EI* is equity issuance (ΔItem 60 + ΔItem 74 –ΔItem 36) during the fiscal year, scaled by lagged assets. *SIGMA* is the monthly stock return volatility during the five year period (or, at least two years) preceding the fiscal year. *B/P* is the book equity to price ratio. *V/P* is the residual-income-value to price ratio. *KZ* index is a measure of financial constraints as defined in Kaplan and Zingales (1997) but with *q* omitted, with high index indicating high level of constraints. *Turnover* is monthly trading volume scaled by the number of shares outstanding. Except for the investment variables in Panel A, and cash flow (*CF*) and equity issuance (*EI*) in Panel B, which are measured over each fiscal year, all other control variables, valuation variables, and valuation sensitivity variables are measured in the month preceding the beginning of each fiscal year. We choose the most recent fiscal year accounting data available at the end of June each year so that each sample firm appears once for a particular year. Total assets figures are in 2005 dollar. All variables are winsorized at the 1^{st} and 99^{th} percentiles.

	N	Mean	Std Dev	Median	Min	Max
Panel A. Investment Variables						
CAPX (%)	52,980	8.72	8.75	6.23	0.33	47.60
RD (%)	30,698	7.64	10.88	3.64	0	58.50
TOTINV (%)	30,324	15.56	12.96	11.93	1.18	68.95
Panel B. Control Variables for Investment Regressions						
q	51,422	2.126	2.165	1.400	0.591	14.196
CF (%)	53,262	12.51	13.65	11.94	-31.52	50.22
LEV	53,160	0.31	0.23	0.30	0	0.87
EI (%)	50,779	7.01	43.06	0.98	-13.91	119.59
SIGMA (%)	49,386	13.25	6.76	11.82	4.29	37.33
Panel C. Valuation Variables						
B/P	53,354	0.669	0.607	0.515	0.042	3.259
V/P	53,354	0.733	0.672	0.628	-0.958	3.552
Panel D. Variables Affecting the Investment-Valuation Sensitivity						
KZ Index	49,503	0.04	1.21	0.09	-4.15	2.39
Turnover (%)	51,936	10.01	11.89	5.72	0.49	60.79
Total Assets ($M)	53,354	2,615.5	11,966.4	385.9	13.5	34,531.2

Table 2. Capital and R&D Expenditures, and Valuations by Year

This table reports the mean values of investment levels: capital expenditures (*CAPX*), R&D expenditures (*RD*), total investment expenditures (*TOTINV*) (sum of the two), and cash flow (*CF*), all scaled by lagged total assets for each fiscal year. Also reported are the mean and median of *B/P*, the book equity to price ratio; and *V/P*, the residual-income-value to price ratio. Each sample firm appears once for a particular year. *N* is the number of observations each year with non-missing *CAPX* or *RD* or both. All variable entries are mean values unless specified as median (Med).

Year	*N*	*CAPX* (%)	*RD* (%)	*TOTINV* (%)	*CF* (%)	*B/P*	*B/P* (Med)	*V/P*	*V/P* (Med)
1977	545	9.84	2.91	12.04	14.38	1.036	0.919	0.808	0.753
1978	770	10.60	3.14	12.80	15.28	0.807	0.709	0.756	0.704
1979	877	11.89	3.30	14.24	15.93	0.862	0.769	0.740	0.711
1980	1,257	11.67	3.29	14.10	15.36	0.981	0.862	0.647	0.636
1981	1,346	11.61	3.51	14.29	14.40	0.935	0.804	0.542	0.521
1982	1,344	11.79	3.61	14.10	14.10	0.921	0.782	0.479	0.445
1983	1,356	9.96	3.92	13.02	12.35	0.922	0.802	0.613	0.559
1984	1,457	8.67	4.49	12.85	12.95	0.895	0.770	0.631	0.588
1985	1,561	10.30	5.13	15.13	13.56	0.625	0.539	0.464	0.397
1986	1,766	10.35	5.65	15.78	12.48	0.738	0.632	0.712	0.648
1987	1,751	9.56	5.65	14.98	11.69	0.677	0.583	0.634	0.591
1988	1,735	8.78	5.52	13.89	12.51	0.631	0.531	0.659	0.613
1989	1,754	8.86	5.92	14.32	13.51	0.679	0.551	0.867	0.738
1990	1,783	8.82	6.26	14.45	13.68	0.650	0.548	0.733	0.689
1991	1,864	8.66	6.70	14.84	12.66	0.638	0.531	0.629	0.597
1992	1,821	7.79	6.47	13.93	12.37	0.820	0.632	0.795	0.727
1993	1,876	7.75	7.25	14.55	13.05	0.662	0.520	0.814	0.744
1994	1,955	8.33	8.14	16.15	12.76	0.585	0.468	0.877	0.782
1995	2,140	8.90	8.95	17.13	13.68	0.524	0.417	0.875	0.786
1996	2,379	9.32	9.37	17.91	13.50	0.552	0.444	0.825	0.780
1997	2,546	9.45	9.52	18.31	13.49	0.527	0.392	0.750	0.645
1998	2,660	9.56	10.09	18.33	12.97	0.480	0.366	0.641	0.529
1999	2,812	9.24	10.82	18.73	12.09	0.456	0.349	0.595	0.516
2000	2,655	8.06	10.46	17.74	12.41	0.576	0.425	0.700	0.576
2001	2,425	8.27	10.39	18.07	12.54	0.613	0.429	0.663	0.526
2002	2,312	6.85	8.44	14.53	7.55	0.735	0.430	0.618	0.479
2003	2,287	5.37	9.19	13.78	7.38	0.689	0.457	0.793	0.601
2004	2,173	5.32	9.14	13.59	10.45	0.818	0.577	1.208	1.062
2005	2,147	5.77	8.83	13.79	12.59	0.503	0.393	0.987	0.711
All	53,354	8.72	7.64	15.56	12.51	0.669	0.515	0.733	0.628

Table 3. Investment Activities of Firms Sorted by Valuation Measures: Full Sample

The sample includes U.S. non-financial firms listed on NYSE, AMEX and NASDAQ that are covered by COMPUSTAT and I/B/E/S during 1977-2005. Each year, firms are sorted into quintile portfolios according to the beginning-of-fiscal-year book to price ratio (*B/P*), or residual-income-model-value to price ratio (*V/P*). The valuation portfolios are formed annually and include firms with no restriction on fiscal year-end month. Each year, mean investment levels are computed for each valuation quintile. Finally, time-series mean of the investment levels for each quintile is computed. This table reports the time-series mean of capital expenditures (*CAPX*), R&D expenditures (*RD*), and total investment expenditures (*TOTINV*) (sum of the two), all scaled by lagged total assets for each fiscal year, for each valuation portfolio. Difference in investment levels between the most over- and under-valued portfolios, and the associated *t*-statistic of the difference, are also reported. *N* is the time-series average number of firms in each portfolio with non-missing *CAPX* or *RD* or both. The bottom row in each panel reports the time-series mean of the yearly investment-valuation sensitivity ratio, defined as the ratio of interquintile spread in investment to the spread in valuation (measured by either *B/P* or *V/P*) for each investment category.

Valuation Portfolio	*N*	Valuation Ratio	*CAPX* (%)	*RD* (%)	*TOTINV* (%)
		Sorting by ***B/P***			
1 (Overvalued)	367.7	0.189	12.20	10.10	21.49
2	368.1	0.380	9.87	6.90	15.71
3	368.1	0.574	9.06	5.73	13.74
4	368.1	0.815	7.90	5.32	12.30
5 (Undervalued)	367.8	1.584	6.02	4.56	9.98
Difference 1 – 5		-1.395	6.18	5.54	11.51
(*t*-statistic)			(12.71)	(10.01)	(20.89)
Δ*Investment* / Δ(*B/P*)			4.53	4.25	8.65
		Sorting by ***V/P***			
1 (Overvalued)	367.7	0.073	10.13	11.92	21.32
2	368.1	0.418	9.61	6.95	15.82
3	368.1	0.645	8.80	4.93	12.79
4	368.1	0.921	8.52	3.95	11.70
5 (Undervalued)	367.8	1.573	8.01	3.62	10.75
Difference 1 – 5		-1.500	2.12	8.30	10.58
(*t*-statistic)			(4.64)	(9.09)	(14.90)
Δ*Investment* / Δ(*V/P*)			2.12	5.32	7.52

Table 4. Investment Activities of Firms Sorted by Valuation Measures: KZ Subsamples

Each year, firms are sorted into quintile portfolios according to the beginning-of-fiscal-year book to price ratio (*B/P*), or residual-income-model-value to price ratio (*V/P*). The valuation portfolios are formed annually and include firms with no restriction on fiscal year-end month. Each year, mean investment levels are computed for each valuation quintile. Finally, time-series mean of the investment levels for each quintile is computed. This table reports the time-series mean of capital expenditures (*CAPX*), R&D expenditures (*RD*), and total investment expenditures (*TOTINV*) (sum of the two), all scaled by lagged total assets for each fiscal year, for each valuation portfolio. Difference in investment levels between the most over- and under-valued portfolios, and the associated *t*-statistic of the difference, are also reported. *N* is the time-series average number of firms in each portfolio with non-missing *CAPX* or *RD* or both. Panels A and B report results for subsamples sorted by the beginning-of-fiscal-year Kaplan-Zingales (1997) financial constraints index (omitting q from the index). The bottom row in panels A and B reports the time-series mean of the yearly investment-valuation sensitivity ratio, defined as the ratio of interquintile spread in investment to the spread in valuation (measured by either *B/P* or *V/P*) for each investment category. Panel C reports the time-series mean and associated *t*-statistic of the difference in investment-valuation sensitivity ratio between the high and low KZ subsamples.

Table 4. Continued.

Panel A. Subsample of high (above median) KZ index.

Valuation Portfolio	*N*	Valuation Ratio	*CAPX* (%)	*RD* (%)	*TOTINV* (%)
		Sorting by *B/P*			
1 (Overvalued)	170.2	0.234	13.16	7.37	19.07
2	171.0	0.472	10.24	4.14	12.75
3	170.7	0.687	8.97	3.62	11.11
4	171.0	0.955	7.63	3.27	9.98
5 (Undervalued)	170.4	1.847	5.55	2.72	7.66
Difference 1 – 5		-1.613	7.61	4.65	11.40
(*t*-statistic)			(9.95)	(9.53)	(14.79)
Δ*Investment* / Δ(*B/P*)			4.72	3.12	7.28
		Sorting by *V/P*			
1 (Overvalued)	170.2	0.120	10.44	7.77	17.15
2	171.0	0.490	10.06	4.50	13.01
3	170.7	0.729	8.82	3.00	10.54
4	171.0	1.019	8.32	2.73	9.91
5 (Undervalued)	170.4	1.694	7.92	2.73	9.56
Difference 1 – 5		-1.574	2.53	5.05	7.59
(*t*-statistic)			(5.05)	(9.05)	(12.88)
Δ*Investment* / Δ(*V/P*)			2.25	3.25	5.52

Panel B. Subsample of low (below median) KZ index.

Valuation Portfolio	*N*	Valuation Ratio	*CAPX* (%)	*RD* (%)	*TOTINV* (%)
		Sorting by *B/P*			
1 (Overvalued)	170.3	0.176	11.16	11.01	21.85
2	171.0	0.333	9.21	7.97	16.70
3	170.9	0.490	8.70	7.03	15.19
4	171.0	0.693	7.76	6.62	13.93
5 (Undervalued)	170.5	1.262	6.47	6.36	12.39
Difference 1 – 5		-1.086	4.69	4.65	9.46
(*t*-statistic)			(19.85)	(9.41)	(18.72)
Δ*Investment* / Δ(*B/P*)			4.47	4.52	9.14
		Sorting by *V/P*			
1 (Overvalued)	170.3	0.082	9.50	13.38	22.61
2	171.0	0.385	8.88	8.19	16.73
3	170.9	0.577	8.50	6.41	14.46
4	171.0	0.828	8.33	4.96	12.94
5 (Undervalued)	170.5	1.422	8.11	4.51	11.99
Difference 1 – 5		-1.340	1.39	8.87	10.62
(*t*-statistic)			(3.16)	(9.39)	(14.85)
Δ*Investment* / Δ(*V/P*)			1.74	6.35	8.32

Panel C. Difference in investment-valuation sensitivity ratio between high and low KZ subsamples.

	CAPX (%)	*RD* (%)	*TOTINV* (%)
Sorting by *B/P*			
High – Low KZ	0.24	-1.40	-1.85
(*t*-statistic)	(0.84)	(-3.70)	(-3.61)
Sorting by *V/P*			
High – Low KZ	0.51	-3.10	-2.80
(*t*-statistic)	(1.89)	(-7.80)	(-5.16)

Table 5. Investment Activities of Firms Sorted by Valuation Measures: Turnover Subsamples

Each year, firms are sorted into quintile portfolios according to the beginning-of-fiscal-year book to price ratio (*B/P*), or residual-income-model-value to price ratio (*V/P*). The valuation portfolios are formed annually and include firms with no restriction on fiscal year-end month. Each year, mean investment levels are computed for each valuation quintile. Finally, time-series mean of the investment levels for each quintile is computed. This table reports the time-series mean of capital expenditures (*CAPX*), R&D expenditures (*RD*), and total investment expenditures (*TOTINV*) (sum of the two), all scaled by lagged total assets for each fiscal year, for each valuation portfolio. Difference in investment levels between the most over- and under-valued portfolios, and the associated *t*-statistic of the difference, are also reported. *N* is the time-series average number of firms in each portfolio with non-missing *CAPX* or *RD* or both. Panels A and B report results for subsamples sorted by the beginning-of-fiscal-year share turnover (monthly trading volume divided by shares outstanding). The bottom row in panels A and B reports the time-series mean of the yearly investment-valuation sensitivity ratio, defined as the ratio of interquintile spread in investment to the spread in valuation (measured by either *B/P* or *V/P*) for each investment category. Panel C reports the time-series mean and associated *t*-statistic of the difference in investment-valuation sensitivity ratio between the high and low turnover subsamples.

Table 5. Continued.

Panel A. Subsample of high (above median) share turnover.

Valuation Portfolio	*N*	Valuation Ratio	*CAPX* (%)	*RD* (%)	*TOTINV* (%)
		Sorting by *B/P*			
1 (Overvalued)	178.7	0.168	13.29	11.46	23.82
2	179.3	0.335	10.68	8.67	18.31
3	179.1	0.509	9.83	7.20	15.62
4	179.3	0.745	8.40	6.49	13.79
5 (Undervalued)	178.8	1.516	6.26	5.53	11.04
Difference 1 – 5		-1.347	7.03	5.93	12.78
(*t*-statistic)			(12.37)	(9.74)	(20.49)
Δ*Investment* / Δ(*B/P*)			5.21	4.87	10.00
		Sorting by *V/P*			
1 (Overvalued)	178.7	0.044	10.54	13.30	23.04
2	179.3	0.351	10.51	8.73	18.43
3	179.1	0.541	9.60	6.76	15.22
4	179.3	0.782	9.30	4.96	13.06
5 (Undervalued)	178.8	1.419	8.52	4.45	12.09
Difference 1 – 5		-1.375	2.02	8.86	10.95
(*t*-statistic)			(3.74)	(8.78)	(13.99)
Δ*Investment* / Δ(*V/P*)			2.25	6.21	8.39

Panel B. Subsample of low (below median) share turnover.

Valuation Portfolio	*N*	Valuation Ratio	*CAPX* (%)	*RD* (%)	*TOTINV* (%)
		Sorting by *B/P*			
1 (Overvalued)	178.8	0.243	10.15	6.81	16.09
2	179.3	0.460	9.07	4.68	12.80
3	179.4	0.657	8.43	4.36	11.89
4	179.3	0.886	7.52	4.10	10.72
5 (Undervalued)	178.9	1.652	5.79	3.93	9.22
Difference 1 – 5		-1.408	4.35	2.88	6.87
(*t*-statistic)			(12.90)	(7.32)	(15.75)
Δ*Investment* / Δ(*B/P*)			3.24	2.12	5.11
		Sorting by *V/P*			
1 (Overvalued)	178.8	0.134	8.73	8.70	16.48
2	179.3	0.530	8.44	4.50	12.12
3	179.4	0.771	8.07	3.52	11.00
4	179.3	1.050	8.02	3.20	10.64
5 (Undervalued)	178.9	1.671	7.71	3.19	9.90
Difference 1 – 5		-1.537	1.02	5.51	6.58
(*t*-statistic)			(3.27)	(7.07)	(11.02)
Δ*Investment* / Δ(*V/P*)			1.03	3.29	4.45

Panel C. Difference in investment-valuation sensitivity ratio between high and low turnover subsamples.

	CAPX (%)	*RD* (%)	*TOTINV* (%)
Sorting by *B/P*			
High – Low Turnover	1.97	2.74	4.88
(*t*-statistic)	(9.15)	(4.76)	(8.34)
Sorting by *V/P*			
High – Low Turnover	1.22	2.92	3.94
(*t*-statistic)	(2.64)	(7.17)	(7.95)

Table 6. Investment Activities of Firms Sorted by Valuation Measures: Size Subsamples

Each year, firms are sorted into quintile portfolios according to the beginning-of-fiscal-year book to price ratio (*B/P*), or residual-income-model-value to price ratio (*V/P*). The valuation portfolios are formed annually and include firms with no restriction on fiscal year-end month. Each year, mean investment levels are computed for each valuation quintile. Finally, time-series mean of the investment levels for each quintile is computed. This table reports the time-series mean of capital expenditures (*CAPX*), R&D expenditures (*RD*), and total investment expenditures (*TOTINV*) (sum of the two), all scaled by lagged total assets for each fiscal year, for each valuation portfolio. Difference in investment levels between the most over- and under-valued portfolios, and the associated *t*-statistic of the difference, are also reported. *N* is the time-series average number of firms in each portfolio with non-missing *CAPX* or *RD* or both. Panels A and B report results for subsamples sorted by the beginning-of-fiscal-year firm size (total assets). The bottom row in panels A and B reports the time-series mean of the yearly investment-valuation sensitivity ratio, defined as the ratio of interquintile spread in investment to the spread in valuation (measured by either *B/P* or *V/P*) for each investment category. Panel C reports the time-series mean and associated *t*-statistic of the difference in investment-valuation sensitivity ratio between the large and small size subsamples.

Table 6. Continued.

Panel A. Subsample of large firms (above median total assets).

Valuation Portfolio	*N*	Valuation Ratio	*CAPX* (%)	*RD* (%)	*TOTINV* (%)
		Sorting by *B/P*			
1 (Overvalued)	183.6	0.230	11.30	6.40	16.92
2	184.2	0.429	9.84	3.86	12.54
3	184.1	0.612	9.02	3.33	11.26
4	184.2	0.817	8.01	3.20	10.66
5 (Undervalued)	183.6	1.556	6.28	2.61	8.58
Difference 1 – 5		-1.326	5.01	3.79	8.34
(*t*-statistic)			(11.73)	(12.33)	(20.66)
Δ*Investment* / Δ(*B/P*)			3.87	3.06	6.59
		Sorting by *V/P*			
1 (Overvalued)	183.6	0.196	10.38	6.44	16.07
2	184.2	0.514	9.47	4.49	13.04
3	184.1	0.733	8.51	3.30	11.00
4	184.2	0.992	8.40	2.79	10.65
5 (Undervalued)	183.6	1.559	7.70	2.17	9.26
Difference 1 – 5		-1.363	2.67	4.27	6.81
(*t*-statistic)			(6.96)	(11.05)	(15.40)
Δ*Investment* / Δ(*V/P*)			2.54	3.17	5.52

Panel B. Subsample of small firms (below median total assets).

Valuation Portfolio	*N*	Valuation Ratio	*CAPX* (%)	*RD* (%)	*TOTINV* (%)
		Sorting by *B/P*			
1 (Overvalued)	183.6	0.161	12.99	12.73	24.91
2	184.3	0.337	10.20	9.52	18.60
3	184.3	0.529	8.98	8.22	16.23
4	184.3	0.808	7.73	6.91	13.53
5 (Undervalued)	183.8	1.606	5.76	5.80	10.73
Difference 1 – 5		-1.445	7.22	6.93	14.18
(*t*-statistic)			(11.90)	(9.28)	(21.13)
Δ*Investment* / Δ(*B/P*)			5.13	5.05	10.22
		Sorting by *V/P*			
1 (Overvalued)	183.6	-0.022	9.99	14.82	24.09
2	184.3	0.339	9.67	9.35	18.34
3	184.3	0.551	8.94	7.08	15.36
4	184.3	0.836	8.81	5.50	13.14
5 (Undervalued)	183.8	1.561	8.25	4.66	11.67
Difference 1 – 5		-1.583	1.74	10.15	12.42
(*t*-statistic)			(2.73)	(8.79)	(14.76)
Δ*Investment* / Δ(*V/P*)			2.18	6.16	8.61

Panel D. Difference in investment-valuation sensitivity ratio between large and small subsamples.

	CAPX (%)	*RD* (%)	*TOTINV* (%)
Sorting by *B/P*			
Large – Small Size	-1.26	-1.99	-3.62
(*t*-statistic)	(-4.31)	(-5.22)	(-8.97)
Sorting by *V/P*			
Large – Small Size	0.36	-3.00	-3.10
(*t*-statistic)	(0.91)	(-10.28)	(-6.51)

Table 7. Fama-MacBeth Regressions of Investment Levels on Valuation Measures: Full Sample

The dependent variable is one of following investment levels: capital expenditures (*CAPX*), R&D (*RD*), and sum of the expenditures (*TOTINV*) all scaled by lagged total assets. The independent variables include beginning-of-year *V/P* (the residual-income-model-value to price ratio) and *B/P* (book to price ratio). *q* is the beginning-of-year Tobin's *q* ratio. *CF* is cash flow (Item 14 + Item 18 + *RD*) scaled by lagged assets (missing *RD* is set to zero in the *CF* calculation). *LEV* is beginning-of-year leverage defined as (Item 9 + Item 34)/(Item 9 + Item 34 + Item 216). *SIGMA* is the stock return volatility during the five-year period (or, at least two years) preceding the fiscal year. *EI* is equity issuance (ΔItem 60 + ΔItem 74 –ΔItem 36) scaled by lagged assets. This table reports the time-series weighted average (first row) and *t*-statistic (second row) of the coefficients of cross-sectional regressions, where the weight is the number of firms in each yearly regression. *X-Obs* is the average number of firms in the cross-sectional regressions; there are 29 yearly cross-sectional regressions for each model specification. All regressions include 2-digit SIC major industry dummies. The sample includes U.S. non-financial firms listed on NYSE, AMEX and NASDAQ with COMPUSTAT and I/B/E/S coverage during 1977-2005.

	V/P	*B/P*	*q*	*CF*	*LEV*	*SIGMA*	*EI*	Intercept	*X-obs*
				Dependent variable: *CAPX*					
(1)		-1.566	0.428	0.191	3.106	0.088		3.595	1618.2
		(-9.59)	(4.72)	(11.63)	(5.35)	(8.68)		(5.98)	
(2)	-0.479		0.603	0.207	3.127	0.070		2.560	1618.2
	(-3.40)		(7.13)	(11.84)	(5.39)	(6.60)		(4.62)	
(3)	-0.429	-1.912		0.203	2.701	0.112		4.520	1681.9
	(-2.74)	(-9.50)		(12.11)	(4.46)	(8.42)		(6.78)	
(4)	-0.313	-1.748		0.199	2.549	0.073	0.082	4.676	1598.0
	(-2.15)	(-9.48)		(13.49)	(4.78)	(6.13)	(7.76)	(7.45)	
				Dependent variable: *RD*					
(1)		0.364	0.428	0.134	-5.328	0.467		-1.618	920.5
		(3.12)	(6.23)	(11.40)	(-5.26)	(8.89)		(-3.63)	
(2)	-1.745		0.260	0.135	-4.712	0.441		0.389	920.5
	(-6.87)		(3.43)	(13.15)	(-5.01)	(8.57)		(0.84)	
(3)	-1.999	0.088		0.149	-5.263	0.458		0.738	964.5
	(-7.89)	(0.46)		(13.85)	(-5.38)	(8.41)		(1.19)	
(4)	-1.737	0.685		0.159	-4.926	0.372	0.084	0.644	907.9
	(-8.24)	(4.37)		(17.20)	(-5.14)	(8.99)	(6.38)	(1.10)	
				Dependent variable: *TOTINV*					
(1)		-1.039	0.991	0.272	-3.347	0.482		2.951	908.9
		(-4.61)	(8.56)	(12.02)	(-2.45)	(9.49)		(3.06)	
(2)	-2.139		0.954	0.284	-2.733	0.444		4.068	908.9
	(-7.01)		(8.53)	(13.49)	(-2.16)	(9.18)		(4.23)	
(3)	-2.453	-1.838		0.305	-3.714	0.507		6.382	952.6
	(-8.36)	(-5.90)		(12.95)	(-2.76)	(9.29)		(5.27)	
(4)	-2.063	-1.088		0.313	-3.552	0.384	0.154	6.507	896.5
	(-8.30)	(-4.94)		(15.20)	(-2.90)	(10.11)	(13.21)	(5.76)	

Table 8. Fama-MacBeth 2-Stage Least Squares (2SLS) Investment Regressions: Full Sample

The dependent investment variables include capital expenditures (*CAPX*), R&D (*RD*), and sum of the expenditures (*TOTINV*) all scaled by lagged total assets. The independent variables include beginning-of-year *V/P* (the residual-income-model-value to price ratio) and *B/P* (book to price ratio); see Table 7 for definition of other control variables. Each year, 2-stage least squares (2SLS) cross-sectional regressions are performed for model (4) in Table 7, with equity issuance (*EI*) being an endogenous variable. The first-stage *EI* regression includes 2-digit SIC major industry dummies in addition to the exogenous variables (*V/P, B/P, CF, LEV,* and *SIGMA*) in the independent variables. In the second-stage investment regression, the endogenous variable *EI* is the predicted value from the first-stage regression. This table reports results of the *EI* and investment regressions, as well as the reduced form investment regression for each investment (*CAPX, RD*, and *TOTINV*). The system of equations for the 2SLS for each investment variable is presented first, followed by the time-series weighted average (first row) and *t*-statistic (second row) of the coefficients, where the weight is the number of firms in each yearly regression. *X-Obs* is the average number of firms in the cross-sectional regressions; there are 29 yearly cross-sectional regressions for each model specification. The sample includes U.S. non-financial firms listed on NYSE, AMEX and NASDAQ with COMPUSTAT and I/B/E/S coverage during 1977-2005.

Dependent Variable	*V/P*	*B/P*	*CF*	*LEV*	*SIGMA*	*EI*	Intercept	*X-obs*
$EI = a_1 + b_1 V/P + c_1 B/P + d_1 CF + e_1 LEV + f_1 SIGMA + u_1$								
$CAPX = a_2 + b_2 V/P + c_2 B/P + d_2 CF + e_2 LEV + f_2 SIGMA + g_2 \widehat{EI} + u_2$								
EI	-2.222	-4.537	-0.022	-0.581	0.739		-0.418	1598.0
	(-5.47)	(-5.67)	(-0.51)	(-0.48)	(7.08)		(-0.39)	
CAPX	-0.094	-1.904	0.152	3.750	0.018	0.165	5.984	1598.0
	(-0.37)	(-5.83)	(9.26)	(5.71)	(0.40)	(2.42)	(8.10)	
CAPX	-0.258	-1.972	0.194	4.862	0.074		4.997	1598.0
(Reduced form)	(-1.43)	(-10.79)	(11.33)	(6.74)	(4.82)		(7.06)	
$EI = a_1 + b_1 V/P + c_1 B/P + d_1 CF + e_1 LEV + f_1 SIGMA + u_1$								
$RD = a_2 + b_2 V/P + c_2 B/P + d_2 CF + e_2 LEV + f_2 SIGMA + g_2 \widehat{EI} + u_2$								
EI	-3.018	-5.785	-0.047	-1.071	0.914		-1.387	907.9
	(-5.07)	(-5.21)	(-0.95)	(-0.84)	(6.47)		(-0.74)	
RD	-1.002	2.893	0.228	-4.405	0.093	0.438	-1.036	907.9
	(-4.28)	(5.11)	(12.86)	(-4.23)	(1.76)	(4.34)	(-1.76)	
RD	-2.426	-0.195	0.158	-5.995	0.486		0.437	907.9
(Reduced form)	(-8.40)	(-0.71)	(12.09)	(-6.02)	(8.64)		(0.61)	
$EI = a_1 + b_1 V/P + c_1 B/P + d_1 CF + e_1 LEV + f_1 SIGMA + u_1$								
$TOTINV = a_2 + b_2 V/P + c_2 B/P + d_2 CF + e_2 LEV + f_2 SIGMA + g_2 \widehat{EI} + u_2$								
EI	-3.054	-5.770	-0.045	-1.175	0.914		-1.325	896.5
	(-5.11)	(-5.18)	(-0.91)	(-0.91)	(6.55)		(-0.73)	
TOTINV	-1.414	0.277	0.322	-3.253	0.165	0.467	6.181	896.5
	(-6.20)	(0.64)	(16.92)	(-2.76)	(3.74)	(5.36)	(6.46)	
TOTINV	-2.653	-2.189	0.301	-3.811	0.517		6.406	896.5
(Reduced form)	(-8.01)	(-6.24)	(11.87)	(-2.75)	(9.35)		(5.17)	

Table 9. Investment Sensitivity to Valuation by Valuation Level

Each year, firms are sorted into valuation quintiles by the beginning-of-fiscal-year *V/P* level. Two-stage least squares (2SLS) regressions as in Table 8 are performed for each valuation quintile. For each quintile, for each of the capital expenditures (*CAPX*), R&D (*RD*), and sum of the expenditures (*TOTINV*) regressions, this table reports only the weighted average of the *V/P* coefficient (*b*) and the associated *t*-statistic in the 2SLS regressions, which measure the direct, indirect, or full effect of *V/P* on investment, where the weight is the number of firms in each cross-sectional regression. Panel A reports the *V/P* coefficient in the second-stage 2SLS investment regression (direct effect of *V/P* on investment), Panel C reports the *V/P* coefficient in the reduced form 2SLS regression (full effect), and Panel B the difference between the full and direct effects (indirect effect). The bottom row of each panel reports the difference in coefficients between quintiles 1 and 5, based on the time-series of coefficients of the cross-sectional regressions for the two quintiles.

Panel A. *V/P* coefficient in the 2SLS investment regression (the second regression of each of the *CAPX, RD,* and *TOTINV* 2SLS regressions in Table 8), which measures the direct effect of *V/P* on investment.

V/P Quintile	*CAPX*		*RD*		*TOTINV*	
	b	***t*-statistic**	***b***	***t*-statistic**	***b***	***t*-statistic**
1 (Overvalued)	-1.915	-2.11	-9.071	-4.69	-10.094	-6.36
2	-3.056	-1.85	-1.831	-0.63	-1.976	-0.71
3	-1.528	-1.12	-0.488	-0.54	-2.109	-0.99
4	0.340	0.41	0.840	1.05	-0.163	-0.14
5 (Undervalued)	0.119	0.62	-0.091	-0.45	-0.084	-0.30
Difference 5 – 1	2.036	2.16	8.978	4.49	10.007	6.10

Panel B. *V/P* coefficient from the effect of *EI* in the 2SLS investment regressions (in Table 8 notation, $b_1 g_2$), which measures the indirect effect of *V/P* on investment through equity issuance.

V/P Quintile	*CAPX*		*RD*		*TOTINV*	
	b	***t*-statistic**	***b***	***t*-statistic**	***b***	***t*-statistic**
1 (Overvalued)	0.243	0.52	-3.901	-3.30	-3.683	-3.53
2	-0.722	-0.65	-3.178	-0.98	-1.960	-0.90
3	1.018	1.15	-0.457	-0.75	-1.247	-1.54
4	-0.301	-0.53	-0.963	-1.39	0.162	0.42
5 (Undervalued)	0.177	1.41	0.277	1.37	0.413	1.93
Difference 5 – 1	-0.066	-0.13	4.178	3.32	4.100	3.67

Panel C. *V/P* coefficient in the reduced form 2SLS investment regression (the third regression of each of the *CAPX, RD,* and *TOTINV* 2SLS regressions in Table 8), which measures the full effect of *V/P* on investment.

V/P Quintile	*CAPX*		*RD*		*TOTINV*	
	b	***t*-statistic**	***b***	***t*-statistic**	***b***	***t*-statistic**
1 (Overvalued)	-1.673	-1.93	-12.973	-5.73	-13.777	-7.35
2	-3.777	-2.55	-5.009	-3.74	-3.936	-1.67
3	-0.510	-0.43	-0.945	-1.08	-3.356	-1.78
4	0.039	0.05	-0.124	-0.15	-0.001	0.00
5 (Undervalued)	0.296	1.64	0.186	0.89	0.329	1.23
Difference 5 – 1	1.970	2.30	13.156	5.68	14.107	7.52

Table 10. Investment Sensitivity to Valuation for KZ Quintiles

Each year, firms are sorted into KZ quintiles by the beginning-of-fiscal-year KZ index. Two-stage least squares (2SLS) regressions as in Table 8 are performed for each KZ quintile. For each quintile, for each of the capital expenditures (*CAPX*), R&D (*RD*), and sum of the expenditures (*TOTINV*) regressions, this table reports only the weighted average of the *V/P* coefficient (*b*) and the associated *t*-statistic in the 2SLS regressions, which measure the direct, indirect, or full effect of *V/P* on investment, where the weight is the number of firms in each cross-sectional regression. Panel A reports the *V/P* coefficient in the second-stage 2SLS investment regression (direct effect of *V/P* on investment), Panel C reports the *V/P* coefficient in the reduced form 2SLS regression (full effect), and Panel B the difference between the full and direct effects (indirect effect). The bottom row of each panel reports the difference in coefficients between quintiles 1 and 5, based on the time-series of coefficients of the cross-sectional regressions for the two quintiles.

Panel A. *V/P* coefficient in the 2SLS investment regression (the second regression of each of the *CAPX, RD,* and *TOTINV* 2SLS regressions in Table 8), which measures the direct effect of *V/P* on investment.

KZ Quintile	*CAPX*		*RD*		*TOTINV*	
	b	***t*-statistic**	***b***	***t*-statistic**	***b***	***t*-statistic**
1 (Unconstrained)	0.032	0.09	-2.330	-4.83	-3.115	-6.71
2	-0.013	-0.04	-2.361	-4.50	-2.326	-4.59
3	0.083	0.32	-1.265	-2.87	-1.598	-3.99
4	-0.369	-1.09	-1.699	-6.35	-2.143	-5.86
5 (Constrained)	-0.777	-2.56	-0.754	-3.51	-1.294	-4.08
Difference 5 – 1	-0.809	-1.98	1.574	2.87	1.821	3.12

Panel B. *V/P* coefficient from the effect of *EI* in the 2SLS investment regressions (in Table 8 notation, $b_1 g_2$), which measures the indirect effect of *V/P* on investment through equity issuance.

KZ Quintile	*CAPX*		*RD*		*TOTINV*	
	b	***t*-statistic**	***b***	***t*-statistic**	***b***	***t*-statistic**
1 (Unconstrained)	-0.034	-0.20	-1.580	-2.65	-1.187	-2.38
2	-0.030	-0.13	-1.364	-3.46	-1.252	-3.21
3	-0.106	-0.61	-1.220	-2.81	-0.988	-2.77
4	-0.034	-0.17	-0.821	-2.43	-0.661	-1.96
5 (Constrained)	-0.278	-2.00	-0.274	-1.48	-0.415	-2.07
Difference 5 – 1	-0.244	-1.08	1.307	2.09	0.773	1.46

Panel C. *V/P* coefficient in the reduced form 2SLS investment regression (the third regression of each of the *CAPX, RD,* and *TOTINV* 2SLS regressions in Table 8), which measures the full effect of *V/P* on investment.

KZ Quintile	*CAPX*		*RD*		*TOTINV*	
	b	***t*-statistic**	***b***	***t*-statistic**	***b***	***t*-statistic**
1 (Unconstrained)	-0.002	-0.01	-3.910	-6.95	-4.302	-8.29
2	-0.043	-0.15	-3.725	-6.61	-3.577	-5.73
3	-0.023	-0.11	-2.484	-6.17	-2.586	-5.59
4	-0.403	-1.49	-2.520	-5.84	-2.804	-4.98
5 (Constrained)	-1.055	-3.41	-1.028	-5.91	-1.709	-4.96
Difference 5 – 1	-1.054	-2.61	2.881	4.69	2.593	3.95

Table 11. Investment Sensitivity to Valuation for Turnover Quintiles

Each year, firms are sorted into turnover quintiles by the beginning-of-fiscal-year share turnover. Two-stage least squares (2SLS) regressions as in Table 8 are performed for each turnover quintile. For each quintile, for each of the capital expenditures (*CAPX*), R&D (*RD*), and sum of the expenditures (*TOTINV*) regressions, this table reports only the weighted average of the *V/P* coefficient (*b*) and the associated *t*-statistic in the 2SLS regressions, which measure the direct, indirect, or full effect of *V/P* on investment, where the weight is the number of firms in each cross-sectional regression. Panel A reports the *V/P* coefficient in the second-stage 2SLS investment regression (direct effect of *V/P* on investment), Panel C reports the *V/P* coefficient in the reduced form 2SLS regression (full effect), and Panel B the difference between the full and direct effects (indirect effect). The bottom row of each panel reports the difference in coefficients between quintiles 1 and 5, based on the time-series of coefficients of the cross-sectional regressions for the two quintiles.

Panel A. *V/P* coefficient in the 2SLS investment regression (the second regression of each of the *CAPX, RD,* and *TOTINV* 2SLS regressions in Table 8), which measures the direct effect of *V/P* on investment.

Turnover Quintile	*CAPX*		*RD*		*TOTINV*	
	b	***t*-statistic**	***b***	***t*-statistic**	***b***	***t*-statistic**
1 (Low)	-0.149	-0.72	-1.155	-3.97	-1.269	-4.78
2	-0.404	-1.11	-1.819	-4.87	-1.958	-4.29
3	0.526	2.54	-1.661	-5.25	-1.327	-2.99
4	0.258	0.89	-1.086	-2.79	-1.509	-3.20
5 (High)	-0.064	-0.16	-1.743	-3.09	-2.715	-5.73
Difference 5 – 1	0.085	0.20	-0.588	-1.01	-1.446	-2.76

Panel B. *V/P* coefficient from the effect of *EI* in the 2SLS investment regressions (in Table 8 notation, $b_1 g_2$), which measures the indirect effect of *V/P* on investment through equity issuance.

Turnover Quintile	*CAPX*		*RD*		*TOTINV*	
	b	***t*-statistic**	***b***	***t*-statistic**	***b***	***t*-statistic**
1 (Low)	-0.178	-2.46	-0.657	-2.74	-0.648	-2.86
2	-0.049	-0.25	-0.546	-1.38	-0.643	-1.85
3	-0.443	-2.48	-0.604	-1.69	-0.650	-2.18
4	-0.242	-1.17	-1.830	-3.84	-1.502	-3.67
5 (High)	0.077	0.34	-2.067	-2.76	-1.723	-3.07
Difference 5 – 1	0.255	1.07	-1.410	-1.95	-1.076	-1.94

Panel C. *V/P* coefficient in the reduced form 2SLS investment regression (the third regression of each of the *CAPX, RD,* and *TOTINV* 2SLS regressions in Table 8), which measures the full effect of *V/P* on investment.

Turnover Quintile	*CAPX*		*RD*		*TOTINV*	
	b	***t*-statistic**	***b***	***t*-statistic**	***b***	***t*-statistic**
1 (Low)	-0.327	-1.56	-1.813	-6.08	-1.917	-6.18
2	-0.454	-1.77	-2.365	-5.30	-2.601	-5.42
3	0.083	0.37	-2.266	-5.82	-1.977	-3.91
4	0.016	0.06	-2.915	-7.05	-3.011	-6.13
5 (High)	0.013	0.05	-3.811	-8.86	-4.439	-9.18
Difference 5 – 1	0.340	1.11	-1.998	-6.12	-2.521	-5.51

Table 12. Investment Sensitivity to Valuation for Size Quintiles

Each year, firms are sorted into size quintiles by the beginning-of-fiscal-year firm sizes (total assets). Two-stage least squares (2SLS) regressions as in Table 8 are performed for each size quintile. For each quintile, for each of the capital expenditures (*CAPX*), R&D (*RD*), and sum of the expenditures (*TOTINV*) regressions, this table reports only the weighted average of the *V/P* coefficient (*b*) and the associated *t*-statistic in the 2SLS regressions, which measure the direct, indirect, or full effect of *V/P* on investment, where the weight is the number of firms in each cross-sectional regression. Panel A reports the *V/P* coefficient in the second-stage 2SLS investment regression (direct effect of *V/P* on investment), Panel C reports the *V/P* coefficient in the reduced form 2SLS regression (full effect), and Panel B the difference between the full and direct effects (indirect effect). The bottom row of each panel reports the difference in coefficients between quintiles 1 and 5, based on the time-series of coefficients of the cross-sectional regressions for the two quintiles.

Panel A. *V/P* coefficient in the 2SLS investment regression (the second regression of each of the *CAPX, RD,* and *TOTINV* 2SLS regressions in Table 8), which measures the direct effect of *V/P* on investment.

Size Quintile	*CAPX*		*RD*		*TOTINV*	
	b	***t*-statistic**	***b***	***t*-statistic**	***b***	***t*-statistic**
1 (Small)	-0.048	-0.13	-2.150	-5.47	-2.462	-4.48
2	0.280	0.92	-1.474	-4.42	-1.860	-4.09
3	0.522	1.33	-1.952	-7.62	-2.400	-6.74
4	-0.362	-1.26	-1.174	-4.79	-1.470	-3.54
5 (Large)	-0.225	-1.17	-0.725	-4.82	-0.930	-3.52
Difference 5 – 1	-0.177	-0.44	1.424	4.13	1.532	3.10

Panel B. *V/P* coefficient from the effect of *EI* in the 2SLS investment regressions (in Table 8 notation, b_1g_2), which measures the indirect effect of *V/P* on investment through equity issuance.

Size Quintile	*CAPX*		*RD*		*TOTINV*	
	b	***t*-statistic**	***b***	***t*-statistic**	***b***	***t*-statistic**
1 (Small)	-0.112	-0.58	-1.946	-4.50	-2.023	-4.75
2	-0.449	-2.34	-1.039	-3.24	-0.980	-3.30
3	-0.829	-2.68	-0.682	-3.73	-0.834	-2.92
4	-0.323	-2.63	-0.054	-0.40	-0.081	-0.49
5 (Large)	-0.115	-1.45	0.013	0.23	-0.143	-1.19
Difference 5 – 1	-0.003	-0.01	1.959	4.51	1.882	4.26

Panel C. *V/P* coefficient in the reduced form 2SLS investment regression (the third regression of each of the *CAPX, RD,* and *TOTINV* 2SLS regressions in Table 8), which measures the full effect of *V/P* on investment.

Size Quintile	*CAPX*		*RD*		*TOTINV*	
	b	***t*-statistic**	***b***	***t*-statistic**	***b***	***t*-statistic**
1 (Small)	-0.160	-0.54	-4.097	-8.54	-4.485	-7.12
2	-0.169	-0.66	-2.513	-6.28	-2.840	-6.95
3	-0.307	-1.39	-2.634	-7.90	-3.235	-7.29
4	-0.685	-2.55	-1.228	-5.50	-1.551	-4.15
5 (Large)	-0.340	-1.87	-0.712	-4.92	-1.073	-4.10
Difference 5 – 1	-0.180	-0.59	3.384	7.70	3.413	6.16