Cash Flow Sensitivity of Investment: Firm-Level Analysis

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ABSTRACT

Using firm level estimates of investment-cash flow sensitivity, we find that cash flow sensitive firms are financially constrained and underinvest in low cash flow years, but are not constrained and overinvest in high cash flow years. The accessibility of external capital is positively correlated with cash flows, intensifying investment cash flow sensitivity. Managers actively counteract the variations in internal and external liquidity by accumulating working capital when liquidity is high and draining it when liquidity is low. While financial constraints have an economically significant impact on investment timing, cash flow sensitive firms alleviate their effects and, actually, overinvest, on aggregate.

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A seminal study by Fazzari, Hubbard, and Petersen (1988) finds that, after controlling for growth opportunities, corporate investment is sensitive to cash flow and more so for firms with low dividend payout. The authors conclude that the strong positive effect of internal funds on investment is caused by the liquidity constraints faced by firms with significant differences between the costs of external and internal capital.

The subsequent literature has primarily focused on addressing various problems in the methodology used by Fazzari, Hubbard and Petersen (1988)[1] and has found both supporting[2] and contradicting[3] evidence. The most significant empirical issue is the measurement error in the estimated marginal *Q*. Cash flow may pick up variations in investment opportunities when the estimated *Q* fails to reflect them adequately. If the measurement error in *Q* is more severe for firms classified as financially constrained, then cross-sectional variations in investment-cash flow sensitivity may be observed even in frictionless markets.[4] Alternatively, cash flow may be a better proxy for growth opportunities for certain types of firms. Alti (2003) presents a model where the link between investment and cash flow is stronger for high growth firms, often regarded as financially constrained, because managers adjust current investment in response to cash flow realizations, which reflect current growth opportunities.

[1] These methodological problems were first summarized by Poterba (1988).

[2] Higher investment-cash flow sensitivity is also observed for firms that are young or small (Devereux and Schiantarelli (1990), Oliner and Rudebusch (1992)), have no bond rating (Whited (1992), have low or no credit quality rating (Calomiris, Himmelberg and Wachtel (1996)), for independent Japanese firms, as opposed to firms with close ties to banks (Hoshi, Kashyap, and Scharfstein (1991)). For a more complete survey, see Hubbard (1998) and Schiantarelli (1996).

[3] Alternative classification methods applied by Kaplan and Zingales (1997) and Cleary (1999) yield higher levels of investment-cash flow sensitivity for firms that they classify as least likely to be financially constrained.

[4] For example, Erickson and Whited (2000) argue that the significance of cash flow in investment regressions disappears when they use measurement-error-consistent GMM estimators. Cummins, Hassett, and Oliner (1999) employ firm-specific earnings forecasts from securities analysts to control for expected future profits and find insignificant cash flow coefficients for firms classified as constrained as well as unconstrained. Gilchrist and Himmelberg (1995) use an alternative measure of growth opportunities instead of average *Q* and find that, at least in some cases, the significance of cash flow in investment regressions is due to the fact that it contains information about investment opportunities.

The current paper assesses the relation between investment expenditures and internally generated cash flows using firm-level estimates of investment-cash flow sensitivity and examines whether high sensitivity is associated with economically significant changes in corporate investment and financing behavior.

The paper contributes to the existing literature in a number of ways. First, using firm-level estimates of investment-cash flow sensitivity allows us to classify firms based directly on differences in their investment-cash flow sensitivity and to conduct a multi-aspect cross-sectional analysis for different levels of this measure. In contrast, most of the previous studies have classified firms based on a limited number of a priori characteristics believed to be associated with different levels of financial constraints and obtained group estimates of investment-cash flow sensitivity from investment regressions. The results of our cross-sectional analysis of a large set of firm characteristics support the view that firms with higher investment-cash flow sensitivity are more likely to face liquidity constraints. Since our measure of investment-cash flow sensitivity is independent of *Q*, this evidence cannot be attributed to cross-sectional differences in the measurement error of *Q*.

Second, we extend the studies that use regression analysis to examine the effect of cash flow on investment. The positive effect of cash flow found in such regressions does not tell us whether firms under-invest when internal cash flow is scarce or over-invest when it is ample. Our approach allows us to track how firms with different cash flow sensitivities respond to variations in their cash flows in terms of adjusting the levels and the timing of their investment expenditures. We find that cash flow sensitive firms invest twice as much in their high cash flow years as in their low cash flow years, whereas cash flow insensitive firms show little variation in their investment levels between high and low cash flow years. Furthermore, compared to their industry peers and controlling for differences in market-to-book, cash flow sensitive firms

significantly underinvest in low cash flow years and significantly overinvest in high cash flow years.

Third, we assess how large is the shift in investment timing due to cash flow sensitivity. This is an important factor in determining the economic significance of cash flow sensitivity of investment. Specifically, if the average delay of a capital investment due to financial constraints is relatively short, then the economic effects of financial constraints will be limited even if the effect of cash flow on investment is large in magnitude. Our results indicate that for cash flow sensitive firms the timing distortions are, on average, 3 to 4 years. Such delays are significant and may result in substantial economic losses.

Fourth, we examine how firms with different cash flow sensitivities respond to variations in their cash flows in terms of adjusting other sources and uses of funds. We find that, despite underinvestment, cash flow sensitive firms invest more than their cash flows in low cash flow years. The shortfall of funds is partially covered with debt and equity issuance. However, the ability of these firms to raise additional debt is limited because they are overlevered, while their ability to raise additional equity is limited because their market-to-book ratios are relatively low. In addition, we find that the abnormal returns at the announcements of seasoned equity offerings in low cash flow years are significantly lower for cash flow sensitive firms than for cash flow insensitive firms. Thus, the effect of cash flow shortfalls on investment expenditures is compounded by the fact that external capital is significantly less accessible in low cash flow years. As a result, these firms resort to scaling down their investment in financial slack and net working capital to free up funds for capital investment. These reductions occur despite positive growth in sales, total assets, and net capital and imply that cash flow sensitive firms are financially constrained in years when their cash flows are low.

The picture could not be more different in years when cash flows are high. In these years, cash flow sensitive firms generate cash flows that substantially exceed their capital expenditures.

The significant amounts of internal funds are supplemented by large amounts of new debt and equity financing, made possible by relatively low leverage and relatively high market-to-book ratios of these firms. The generated excess funds are used to shore up the firms' cash positions and net working capital, both of which reach levels far exceeding those predicted based on sales, industry affiliation, and year effects. These results imply that cash flow sensitive firms are not financially constrained in high cash flow years. They also suggest that managers of cash flow sensitive firms act to smooth their investment in time and reduce its sensitivity to cash flow by accumulating excess liquidity in high cash flow years and using it to finance investment in low cash flow years. Such behavior is not consistent with the hypothesis that cash flow sensitivity of investment arises simply because cash flow proxies for investment opportunities.

Our results also extend and complement the studies that examine the effect of cash flow on cash holdings and working capital. Almeida, Campello, and Weisbach (2004) find a significantly positive relation between changes in cash levels and cash flows, but only for firms believed to be financially constrained.[5] They argue that the cash flow sensitivity of cash is consistent with investment smoothing in the presence of financial constraints and is difficult to explain otherwise. However, a positive relation between cash flow and the stock of cash could also arise indirectly since both cash flow and the normal change in cash are likely to be positively related to sales. The current paper shows that this is not the case. For cash flow sensitive firms, the changes in cash are significantly different from the normal changes that could be expected based on the firm’s sales, industry, and year effects. Similarly, Fazzari and Petersen (1993) and Calomiris, Himmelberg, and Wachtel (1995) find a positive relation between cash flow and contemporaneous changes in working capital, especially for firms that pay no dividends or do not have access to commercial paper market. Again, this relation does not necessarily imply that the

changes in working capital are abnormal. Our results, on the other hand, show that the changes are abnormally negative in low cash flow years and abnormally positive in high cash flow years.

Fifth, we examine how traditional measures of financial constraints vary across cash flow sensitive and cash flow insensitive firms, as well as across the cash flow cycle. We find that measures such as size, dividend payout, and investment grade rating identify firms that are likely to face financial constraints at the low point of their cash flow cycle, but do not distinguish years of severe constraints from those when the constraints are temporarily relaxed. In contrast, KZ index distinguishes between more constrained and less constrained years, but does not separate firms potentially facing severe financial constraints from those that do not. Thus, both the traditional criteria of sample separation and the KZ index are useful research tools, since they can serve as reliable indicators of two distinct aspects of financial constraints.

Finally, we extend the literature on cash flow sensitivity of investment by testing whether the effects associated with cash flow sensitivity go beyond investment timing and affect the aggregate investment of the firm over time or whether cash flow sensitive firms are able to overcome their financing problems by accumulating liquidity and/or shifting investment to periods of high cash flows.

We find that underinvestment in low cash flow years and overinvestment in high cash flow years add up to aggregate firm-level investment that is significantly different across the two types of firms. Based on time-series average firm-level investment, cash flow sensitive firms invest significantly more than their industry peers and cash flow insensitive firms. The introduction of various controls for growth opportunities does not change the basic result that cash flow sensitive firms overinvest rather than underinvest, as we might expect for firms that are traditionally described as financially constrained.

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[5] Almeida, Campello, and Weisbach (2004) estimate the cash flow sensitivity of cash separately for groups of firms based on dividend payout, firm size, bond rating, commercial paper rating, and Kaplan-Zingales

The aggregate firm-level overinvestment by cash flow sensitive firms implies that financial constraints are not the only factor that affects corporate investment. Traditionally, corporate finance literature links overinvestment to agency problems (Jensen (1986)). More recently, Malmendier and Tate (2005) relate overinvestment to CEO overconfidence, which leads CEOs to overestimate their ability to generate positive NPV projects.

We do not formally test to distinguish between the agency and the behavioral explanations of our findings. However, our finding that managers take costly measures to accumulate internal liquidity in periods when financial constraints are not binding in order to finance investment in future periods of severe constraints is difficult to explain by agency problems alone. Such behavior is more consistent with CEO overconfidence since it implies a difference of opinion between the market and managers not only about the amount of investment to be undertaken but also about its timing.

The paper proceeds as follows. Section I describes the sample. Section II defines our measure of investment-cash flow sensitivity and examines differences in the characteristics of cash flow sensitive and cash flow insensitive firms. Section III examines the differences in the investment and financing behavior of cash flow sensitive and cash flow insensitive firms in periods when their cash flows are high and low. Section IV describes the implications of cash flow sensitivity about aggregate firm-level investment. Section V concludes the paper.

I. The Sample

Our sample is drawn from COMPUSTAT and covers the 1985 to 2003 time period.[6] We exclude financial institutions (SIC codes 6000-6999) and firms with book values of assets, net

index.

[6] Compustat starts reporting Standard and Poors' credit ratings in 1985.

fixed capital, or sales less than one million dollars. To minimize the influence of outliers in our analysis, we replace extreme observations of all ratio variables with missing values.[7]

Since our analysis uses variables formed on the basis of time series of firm-level observations, only firms with at least two years in the time series are kept in the sample. The sample does not have other survival requirements and includes a substantial number of firms that no longer exist. The final sample is an unbalanced panel dataset of 60,285 observations representing 7,176 firms.

II. Cash Flow Sensitivity of Investment and Its Determinants

A. Measuring Cash Flow Sensitivity of Investment

We measure cash flow sensitivity of investment (*CFSI*) as the difference between the cash flow weighted time-series average investment (*CFWAI*) of a firm and its simple arithmetic time-series average investment (*AI*):

$$CFSI_{0,i} = CFWAI_i - AI_i = \sum_{t=1}^{n} \left(\frac{CF_{it}}{\sum_{t=1}^{n} CF_{it}} \times I_{it} \right) - \frac{1}{n} \sum_{t=1}^{n} I_{it} \, . \qquad (1)$$

In (1), n is the number of annual observations for firm i, and t indicates the time period. *CF* denotes cash flow and is defined as the sum of the income before extraordinary items (Compustat Item 18) and depreciation and amortization (Item 14), divided by the beginning-of-period net capital (Item 8). To avoid negative and extreme weight values, negative cash flows in (1) are set to zero. *I* denotes investment, defined as capital expenditures (Item 128) divided by the beginning-of-period net capital.

[7] Extreme observations include values in the 99th percentile and, for variables with negative values, also those in the 1st percentile.

Since investment and cash flow are measured over an annual period, their exact timings may not coincide. In order to account for the possibility that investment may be financed with cash flows from the previous fiscal year, we also estimate *CFSI* based on *CF* that is lagged relative to investment:

$$CFSI_{-1,i} = \sum_{t=1}^{n} \left(\frac{CF_{it-1}}{\sum_{t=1}^{n} CF_{it-1}} \times I_{it} \right) - \frac{1}{n} \sum_{t=1}^{n} I_{it} \ , \qquad (2)$$

We combine $CFSI_0$ and $CFSI_{-1}$ into an indicator of cash flow sensitivity of investment, which is equal to one if $CFSI_0$ or $CFSI_{-1}$ exceed a threshold level of 0.05 and equal to zero in all other cases.[8] We classify firms as cash flow sensitive (hereafter, CF-sensitive) if this indicator equals one and as cash flow insensitive (hereafter, CF-insensitive) if it equals zero. Based on this classification, 3,007 of our sample firms are CF-sensitive and 4,169 are CF-insensitive.

As reported in Table I, for CF-sensitive firms, the average sensitivity of investment to current cash flow ($CFSI_0$) is 0.132, which is statistically significant at the one percent level. In other words, cash flow weighted average investment exceeds simple average investment by 13.2 percent of net capital. The average sensitivity of investment to lagged cash flow ($CFSI_{-1}$) is 0.121 for these firms, which is also statistically and economically significant. For CF-insensitive firms, both $CFSI_0$ and $CFSI_{-1}$ are statistically and economically insignificant.

To ensure the generality of our further results, we assess the consistency of our method of classification with those applied in the previous literature. We estimate cross-section time-series fixed effects regressions of investment on contemporaneous cash flow and beginning-of-period market-to-book ratio for CF-sensitive and CF-insensitive firms. For brevity, only the regression coefficients of cash flow for the two groups are reported in Table I. Consistent with our

classification, the relation between investment and cash flow is significantly positive for firms classified as CF-sensitive and insignificant for firms classified as CF-insensitive.

B. Characteristics of CF-Sensitive and CF-Insensitive Firms

Most of the previous literature uses estimates of cash flow sensitivity from investment regressions estimated for groups of firms expected to face different levels of financial constraints. Since financial constraints are not directly observable, firms are usually grouped based on a limited number of characteristics believed to be associated with financial constraints.

Because our method estimates investment-cash flow sensitivity on individual firm basis, we can analyze the implications of investment-cash flow sensitivity based directly on its cross-sectional variations, as opposed to variations in firm characteristics that are related to it. Table I presents average firm characteristics for CF-sensitive and CF-insensitive firms. Overall, the results are consistent with the findings of Fazzari, Hubbard, and Petersen (1988) and the supporting literature. Specifically, CF-sensitive firms are significantly smaller and are significantly less likely to pay out dividends than CF-insensitive firms. Although these firms have lower leverage than CF-insensitive firms, they are slightly, but insignificantly, overlevered relative to their industry peers.[9] CF-sensitive firms also have lower borrowing capacity, since they are significantly less likely to have an investment grade rated debt and have lower asset tangibility.[10] These characteristics have been traditionally associated with tighter financial constraints and higher investment-cash flow sensitivity. CF-sensitive firms maintain higher levels of financial slack,[11] which may also indicate potentially higher levels of financial constraints,

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[8] The threshold of 0.05 is ad hoc. We experimented with other threshold values, such as 0, and obtained similar results.

[9] Leverage is the sum of short-term (Item 34) and long-term debt (Item 9) divided by total assets (Item 6). Industry-adjusted leverage is leverage minus the mean leverage of firms in the same industry as defined by the two-digit SIC code.

[10] The investment grade rating indicator is set to 1 if a firm has a Standard and Poors rating of BBB- or higher. The speculative grade rating indicator is set to 1 if a firm has a Standard and Poors rating of BB+ or lower. Asset tangibility is net capital divided by total assets.

[11] Financial slack is defined as cash and marketable securities (Item 1) over net capital.

since firms may accumulate financial slack in order to finance investments when external capital is scarce.[12]

CF-sensitive firms have lower cash flows and higher growth opportunities, as reflected in their significantly higher average market-to-book ratios and higher average sales growth.[13] CF-sensitive firms also have significantly higher volatility of cash flows.[14] The average time-series standard deviation of cash flows is 0.770 for CF-sensitive firms and 0.329 for CF-insensitive firms. The difference is statistically significant at the one percent level. These findings are consistent with the view that cash flow sensitivity is induced by liquidity constraints. In particular, the effect of liquidity constraints on firm investment may be more expressed for high growth firms since they have greater need for external financing. High volatility of cash flows may induce high investment-cash flow sensitivity for financially constrained firms since it makes it more likely that the cash flow constraint on investment will be binding in low cash flow years. Firms with volatile cash flows may also have limited capacity to issue debt, which can further tighten financial constraints. However, the significant difference in cash flow volatility between the two groups may also be due to the way we define the sensitivity indicator. If cash flows do not vary much over time, then cash flow weighted average investment will not be much different from the simple average.

In order to control for a comprehensive set of factors related to cash flow sensitivity, we estimate a probit regression, where the dependent variable equals one for CF-sensitive firms and all the firm characteristics mentioned above are included as explanatory variables. The results

[12] For example, Calomiris, Himmelberg, and Wachtel (1996) find that firms with low or no credit quality ratings hold larger stocks of liquid assets and demonstrate higher investment-cash flow sensitivity. However, other studies argue that firms with ample cash reserves are not liquidity constrained since their investment is not limited by a lack of finance (Kaplan and Zingales (1997), Kashyap, Lamont, and Stein (1994)).

[13] Market-to-book is (total assets – book value of common equity (Item 60) – deferred taxes (Item 35) + market value of equity (Item 199 × Item 25)) / total assets. Sales growth is the change in sales (Item 12) over lagged sales. Asset growth is the change in assets over lagged assets.

[14] The standard deviation of cash flow is the individual firm's time-series standard deviation.

presented in Table II are consistent with our univariate results and with earlier studies that link investment cash flow sensitivity to financial constraints.

We find that cash flow sensitivity increases with market-to-book, as the demand for financing rises with the availability of new investment opportunities. The effect of size remains negative as in Table I, but becomes statistically insignificant. The insignificance of size in Table II is primarily due to being subsumed by the dividend payout indicator, which is highly significantly negative. Cash flow sensitivity of investment is lower in industries with lower leverage, higher for firms with speculative debt rating and lower for firms with investment grade rating. It is also higher for firms with higher cash flow volatility.

While CF-sensitive firms have more financial slack in Table I, the effect of slack in Table II is negative. The change in sign is consistent with the hypothesis that CF-sensitive firms hold more cash so that they use it in periods of low cash flows to smooth their investment over time. Once we control for cash flow volatility in Table II, the effect of slack on cash flow sensitivity becomes negative. In other words, holding the need for cash reserves constant, cash holdings reduce the cash flow sensitivity of investment.

In order to better understand the effect of cash flow on cash flow sensitivity we interact cash flow with indicator variables that split the sample into three equal parts based on firm-level average cash flow. We expect that, other things equal, firms will demonstrate lower cash flow sensitivity either when their cash flows are, on average, so low that they do not play a significant role in project financing or they are, on average, so high that firms are always able to finance all desired projects. For the first category of firms, cash flow sensitivity is expected to increase with an increase in firm-level average cash flow, since cash flow becomes a more and more significant source of investment financing. For the second category of firms, cash flow sensitivity is likely to increase with a decrease in firm-level average cash flow, since more and more often the generated cash flow may be insufficient for financing all desired projects.

The results are consistent with our intuition. In particular, for firms with relatively low average cash flows, increase in average firm-level cash flow is associated with higher cash flow sensitivity. For firms with high average cash flows, decrease in average firm-level cash flow is associated with higher cash flow sensitivity. For firms in the medium average cash flow range, the effect of cash flow is insignificant.

To summarize, the results of the cross-sectional analysis of the characteristics of CF-sensitive and CF-insensitive firms are consistent with the hypothesis that high cash flow sensitivity is driven by financial constraints. These results may also arise if cash flows are a better proxy for growth opportunities for CF-sensitive firms (Alti (2003)). However, they cannot be explained by the cross-sectional variations in measurement error in *Q* (Erickson and Whited, 2000), since our measure of cash flow sensitivity is independent of *Q*.

III. Investment and Financing Behavior in Low and High Cash Flow Periods

Our results show that there is significant variation in investment-cash flow sensitivity across firms, and that CF-sensitive firms have characteristics that are traditionally associated with financial constraints. These results do not yet provide a clear answer to why firms invest less when cash flows are low and more when cash flows are high, or to whether investment-cash flow sensitivity has significant economic effects on firm investment behavior.

In order to address these questions, we examine whether firms under- or over-invest in periods of low and high cash flows and how they finance their investments. We define a year as low cash flow if the cash flow-based weight in equation (1) is less than (1/n), where n is the number of observations in the firm's time series. Otherwise, the year is defined as high cash flow. Tables III, IV, and V, present average firm characteristics reflecting the investment and financing behavior of CF-insensitive and CF-sensitive firms in low- and high cash flow years.

A. Investment across the Cash Flow Cycle

Firm investment in low- and high cash flow periods is presented in Table III. A comparison of investment and cash flow suggests that CF-sensitive firms should not be constrained. In particular, in low cash flow years, CF-sensitive firms invest significantly more (0.238) than their cash flows (-0.089), indicating that investment is not strictly restricted by cash flow. In high cash flow years, CF-sensitive firms invest significantly less (0.507) than their cash flows (0.944), indicating that they could invest more if they wanted to. This impression is further supported by the fact that CF-sensitive firms issue significantly more debt and equity than CF-insensitive firms, both in low- and high cash flow years (Table IV).

A closer examination reveals that, CF-sensitive firms underinvest in low cash flow years and overinvest in high cash flow years. We use several measures of excess investment to assess whether firms overinvest or underinvest. The first measure is simply the difference between the capital expenditure of a firm and the average capital expenditure for firms in the same year and industry (based on the two-digit SIC code). In order to control for firm-specific growth opportunities, the second measure is obtained by estimating cross-sectional regressions of investment on market-to-book ratio for each year and industry, separately. The residuals of these regressions are then used to measure excess investment.

The excess investment of CF-sensitive firms is significantly positive in high cash flow years and significantly negative in low cash flow years based on both measures. The deviations from “normal” investment in Table III are economically significant. For example, the average excess investment of –0.050 implies that in low cash flow years, the investment of CF-sensitive firms is more than seventeen percent lower than their industry mean. The average excess investment of 0.191 implies that in high cash flow years, the investment of CF-sensitive firms exceeds their industry mean by more than fifty percent. Interestingly, the rate of overinvestment

in high cash flow years is about four times higher than the rate of underinvestment in low cash flow years, which suggests that, on average, CF-sensitive firms may be overinvesting.

The excess investment of CF-insensitive firms is negative in both low- and high cash flow years. It is possible that CF-insensitive firms are less capital intensive and, therefore, their low investment rates are not really abnormal. We, therefore, also present excess values of investment defined in terms of net investment (change in net capital). This measure is different from investment defined as capital expenditures because it deducts the depreciation and includes the effects of acquisitions and divestitures. If depreciation reflects the true rate at which the existing fixed assets of a firm have to be replaced in order to maintain the current levels of production, then investment net of depreciation is a better measure of new investment. The results show that the net investment of CF-sensitive firms is not significantly different from zero in low cash flow years, while it is significantly positive in high cash flow years. For CF-insensitive firms, net investment is significantly positive in both low- and high cash flow years.

Similar to excess investment, we calculate excess net investment. We find that the underinvestment of CF-sensitive firms in low cash flow years almost doubles when we use net investment. Overinvestment in high cash flow years also increases but not significantly. For CF-insensitive firms, we now observe overinvestment in high cash flow years, though it is less than one sixth of the overinvestment by CF-sensitive firms. The underinvestment of CF-insensitive firms in low cash flow years also becomes larger, though it is only about half of that of CF-sensitive firms. Finally, we check the asset and sales growth rates and the excess growth rates by cash flow sensitivity type and across high- and low cash flow years. The results in Table III show that asset and sales growth rates follow patterns similar to capital expenditures and, therefore, confirm the robustness of our findings.

The results reported in Table III show that fluctuations in cash flows are positively correlated with deviations from “normal” investment, implying that firms transfer some of their

investments from low- to high cash flow periods. This kind of behavior could arise if firms were more financially constrained in low cash flow periods. It is not clear, though, whether this shift in investment timing is economically significant. For example, if the average length of low cash flow and high cash flow periods is as short as one year, then the distortions in investment timing will be relatively small. We calculate the average spell for high- and low cash flow periods as a proxy for timing distortions. The results indicate that for CF-sensitive firms an average low cash flow period lasts almost four years, and an average high cash flow period lasts 3.4 years. Thus, a firm in its low cash flow spell may have to delay its investment by several years, which may result in significant economic losses.

To summarize, the analysis of investment across the cash flow cycle is consistent with the hypothesis that CF-sensitive firms are financially constrained and underinvest in low cash flow years, but are not constrained and overinvest in high cash flow years. While it seems likely that firm growth opportunities are higher in high cash flow periods than in low cash flow periods, as suggested by Alti (2003), it is hard to explain our results without invoking financial constraints. In order to argue that CF-sensitive firms simply respond to variations in their growth opportunities, one has to accept that market-to-book ratio and industry average investment overstate the marginal growth opportunities in low cash flow periods and understate them in high cash flow periods. The following examination of internal and external financing patterns CF-sensitive and CF-insensitive firms sheds more light on how firms respond to variations in growth opportunities under financial constraints.

B. External Financing across the Cash Flow Cycle

Our results in the previous section indicate that CF-sensitive firms shift a significant portion of their investment from low- to high cash flow years, possibly, because they cannot obtain enough external financing to compensate for the deficit of internal funds in low cash flow years. Indeed, the results in the first rows of Panels A and B in Table IV show that the amounts of

net debt and net equity issued are positively correlated with fluctuations in cash flows. This suggests that external financing constraints become tighter precisely when a firm is in need of external funds, exacerbating the impact of cash flow on corporate investment.[15]

In order to test this hypothesis, we examine the market-to-book and the leverage ratios, of CF-sensitive firms in low- versus high cash flow years. Earlier research (for example, Hovakimian, Opler, and Titman, 2001) provides substantial evidence that leverage ratios and market-to-book ratios are important determinants of external financing decisions. Specifically, firms are reluctant to issue debt when their debt ratios are relatively high, since excessive leverage increases the probability of financial distress. Similarly, firms are reluctant to issue equity when their market-to-book ratios are relatively low, possibly because managers perceive their shares as undervalued.

Our results in Table IV show that in low cash flow years, CF-sensitive firms have market-to-book ratios that are low by a number of standards. First, the market-to-book ratio in an average low cash flow year (1.494) is significantly lower than the market-to-book ratio in an average high cash flow year (1.930). Second, it is also lower than the firm's past market-to-book ratio as indicated by a statistically significant decline of –0.201 compared to the previous year level. Third, it is significantly lower than the industry average market-to-book. The industry-adjusted market-to-book ratio is a statistically significant –0.174. Low market-to-book ratios are likely to make these firms reluctant to issue equity due to perceived or real costs of issuing undervalued equity. Indeed, these firms raise about three and a half times less equity in their low cash flow years than in high cash flow years.

In addition to low market-to-book ratios, CF-sensitive firms face higher indirect issuance costs in the form of a more negative market reaction to equity issue announcements, especially in

[15] Net equity issued is the difference between equity issued (Item 108) and equity repurchased (Item 115), scaled by net capital. Net debt issued is the change in book value of long-term and short-term debt scaled

their low cash flow years. For CF-insensitive firms, the cumulative abnormal returns (CARs) over three days around equity issue announcements are –0.027 and –0.029 in low- and high cash flow years, respectively.[16] For CF-sensitive firms, the respective CARs are –0.040 and –0.033. These results are statistically significant. However, only the difference between CF-sensitive and CF-insensitive firms in low cash flow years is statistically significant.

In low cash flow years, CF-sensitive firms also have relatively high leverage ratios (Table IV, Panel B). The average leverage ratio in low cash flow years (0.273) is significantly higher than the average leverage ratio in high cash flow years (0.221). It is also significantly higher than the average leverage ratio in the firm's industry. The industry-adjusted leverage is a statistically significant 0.025, which is also economically significant, since it means that, at the beginning of a low cash flow year, a CF-sensitive firm has more than 10% higher leverage than its industry peers. Furthermore, at the end of an average low cash flow year, these firms become even more overlevered, with an industry-adjusted debt ratio of 0.032. The increase in leverage is due to the combined effects of relatively low cash flows and a relatively high fraction of debt in new external financing. Overall, these results imply that firms may be unwilling to take on even more debt because they are already overlevered.

In contrast, in high cash flow years, CF-sensitive firms enjoy what seems to be an unconstrained access to external financing. Their market-to-book ratios are significantly higher than in low cash flow years, higher than the market-to-book ratios of CF-insensitive firms, and higher than the industry average market-to-book. Their leverage ratios, on the other hand, are low compared to the leverage ratios in low cash flow years, leverage ratios of CF-insensitive firms, and industry average leverage ratios. As a result, they are able to raise almost five times more

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by net capital. These definitions follow Hovakimian, Opler, and Titman (2001).

[16] These CARs are generated by the market model based on the CRSP value-weighted index and estimated using a 120-day period ending on day -11 relative to the registration filing day. Seasoned equity offerings are obtained from Thomson Research. The number of SEOs with available CARs in our sample is 1,579.

debt in high cash flow periods. The combined amount of equity and debt raised by CF-sensitive firms in high cash flow years is four times the amount raised in low cash flow years.

For CF-insensitive firms, the pattern of changes in external financing between high- and low cash flow periods, although similar to that of CF-sensitive firms, is much less dramatic. This is partially due to the fact that these firms show much less variation in market-to-book and leverage ratios across the cash flow cycle. It is also due to the fact that lower investment rates and more stable cash flows of CF-insensitive firms make their external financing needs more modest than the needs of CF-sensitive firms.

To summarize, market-to-book and leverage ratios of CF-sensitive firms covary with cash flows in ways that make external financing constraints more binding in low cash flow years, exacerbating the shortage of funds and, most likely, amplifying investment-cash flow sensitivity.

C. Internal Liquidity across the Cash Flow Cycle

Next, we examine how firms accumulate and use internal liquidity across the cash flow cycle. Table V reports the changes in financial slack and net working capital, as well as end-of-period values of slack and net working capital, by cash flow sensitivity type and across low and high cash flow periods.[17] The results support our earlier findings that CF-sensitive firms are financially constrained in low cash flow years. Specifically, in these years, CF-sensitive firms significantly reduce their financial slack and the overall net working capital. These declines are not due to firm downsizing since these firms experience small but positive growth in sales and total assets even in low cash flow years (see Table III). In fact, excess (abnormal) changes in slack and net working capital are even more negative and significant. Excess changes are estimated as the residuals from cross-sectional regressions of changes in slack and net working

[17] Since we include short-term debt in our analysis of external financing, our measure of net working capital in this section excludes short-term debt.

capital on changes in sales (all variables scaled by net capital), estimated separately for each year and industry.

In contrast, the availability of both internal and external sources of funds in high cash flow years allows CF-sensitive firms not only to increase their capital investment but also to replenish their net working capital. As can be seen in Table V, changes in slack and net working capital in high cash flow years are significantly positive, both statistically and economically. Excess changes in these measures are also significantly positive implying that the increases are larger than could be justified based on sales growth, industry affiliation, or year effects. While the patterns for CF-insensitive firms are similar, the magnitudes are substantially lower.

We also estimate the excess values of end-of-year levels of slack and net working capital as the residuals from cross-sectional regressions of these variables on sales, estimated separately for each year and industry. The results show that CF-sensitive firms hold excessive amounts of slack and net working capital in their high cash flow years. In low cash flow years, these values drop to levels that are below normal, albeit insignificantly so. For CF-insensitive firms, the levels of slack and net working capital are abnormally low in low cash flow years and are normal in high cash flow years.[18] However, the differences between low and high cash flow years of CF-sensitive firms are from 2.5 to 5 times larger than those of CF-insensitive firms.

These results imply that CF-sensitive firms respond to the significant tightening of liquidity constraints in low cash flow years by cutting back on their investment in net working capital. They use the freed funds to compensate for the declines in cash flows and external financing and prevent further decreases in capital expenditures. The results also imply that the temporary release of external financing constraints in high cash flow years is used to build up the

[18] The generally lower level of slack and net working capital of cash flow insensitive firms may reflect their lower demand for internal liquidity compared to cash flow sensitive firms.

slack and the net working capital to abnormally high levels in anticipation of future tightening of the constraints.

D. Discussion of the Results

The combined evidence on firm investment and financing behavior across the cash flow cycle indicates that lower (higher) levels of cash flow mark periods of lower (higher) liquidity, both internal and external. These results imply that CF-sensitive firms are financially constrained in periods of low cash flows and are not financially constrained in periods of high cash flows. This evidence does not exclude that firm growth opportunities may be lower in low cash flow periods and higher in high cash flow periods, and, in fact, the market's perception of firm growth opportunities seems to be higher when cash flows are high.

However, the presented evidence indicates that financial constraints are an important factor affecting investment-cash flow sensitivity. In particular, there is a substantial "disagreement" between the managers' desire to invest and the availability of internal financing, as well as between the managers' and the markets' perceptions of growth opportunities. When financing becomes less available, managers take extreme measures, including depleting their net working capital and raising external capital at potentially higher costs, in order to finance capital expenditures. When financing becomes abundant, they accumulate internal liquidity in anticipation of future shortages of funds available for investment. These results suggest that in the absence of financial constraints we would most likely observe higher investment levels in low cash flow years and, therefore, lower cash flow sensitivity of investment.

In summary, while responding to possible variations in growth opportunities, managers also seek to mitigate the sensitivity of their investment to cash flow by managing their financial resources in ways that are very hard to explain without invoking financial constraints.

E. Indicators of Financial Constraints across the Cash Flow Cycle

Our findings on firm investment and financing behavior across the cash flow cycle are consistent with the traditional view that firms with higher investment-cash flow sensitivity are more likely to face liquidity constraints. We also find, however, that these firms are constrained only when their cash flows are relatively low. In this section, we examine whether the ex ante indicators of financial constraints used in prior research identify firms that are likely to face liquidity constraints or periods when firms are actually constrained. To do this, we track the variations in firm characteristics, traditionally used to distinguish between firms facing different levels of financial constraints, across the cash flow cycle.

As mentioned earlier, among the criteria most often used to distinguish financially constrained firms in studies of investment-cash flow sensitivity are dividend payout, size, and investment grade rating. An alternative approach is used by Kaplan and Zingales (1997), who classify firms into financially constrained categories using a combination of a number of quantitative firm characteristics with qualitative information extracted from firm annual reports. Based on this classification, they estimate an ordered logit model relating a firm's financial constraint status to its characteristics. More recently, Lamont, Polk, and Saa-Requejo (2001) use the coefficient estimates of five financial ratios from Kaplan and Zingales (1997) to construct a linear combination of these variables, which they label as KZ index. They, as well as a number of subsequent studies, use the KZ index to identify financially constrained firms in their samples.[19] Following Lamont, Polk, and Saa-Requejo (2001), we construct a KZ index for each of our sample observations.[20]

[19] See, for example, Baker, Stein, and Wurgler (2003) and Almeida, Campello, and Weisbach (2004).

[20] KZ index equals: -1.002 * (cash flow / lagged net capital) + 0.283 * (Market-to-book) + 3.139 * (long-term and short-term debt / total assets) – 39.368 * (dividends / lagged net capital) – 1.315 * (slack / lagged net capital).

Table VI presents average size, dividend payout indicator, investment grade rating indicator, and KZ index for CF-sensitive and CF-insensitive firms in their low- and high cash flow years. Higher levels of the KZ index indicate higher likelihood that a firm is financially constrained. As shown, size, dividend payment status, and investment grade debt rating, identify CF-sensitive firms but do not distinguish between constrained and unconstrained years. Specifically, in both high- and low cash flow years, CF-insensitive firms are about four times as large as CF-sensitive firms based on sales, more than three times as likely to pay dividends, and more than six times as likely to have investment grade rated debt. At the same time, the differences between high- and low cash flow years for each category are economically trivial.

In contrast, KZ index is more successful in differentiating between high- and low cash flow years than it is in differentiating between CF-sensitive and CF-insensitive firms. In particular, it is the highest in the low cash flow years of CF-sensitive firms and is the lowest in the high cash flow years of CF-sensitive firms. The differences between KZ indexes for high and low cash flow years are statistically significant at the one percent level for both CF-sensitive and CF-insensitive firms. However, the difference between CF-sensitive and CF-insensitive firms is significant only in low cash flow years. Moreover, although not reported in Table VI, the average KZ index is -1.419 for CF-sensitive firms and -1.503 for CF-insensitive firms. This difference is statistically insignificant. Thus, KZ index seems to be more useful for differentiating between constrained and unconstrained firm-years than for identifying firms that are likely to face financial constraints.

Kaplan and Zingales (1997) also report that firms classified as most likely to be financially constrained demonstrate the lowest investment-cash flow sensitivity and those classified as least likely to be financially constrained demonstrate the highest investment-cash flow sensitivity. Consistent with this evidence, Almeida, Campello, and Weisbach (2004) find that, unlike other indicators of financial constraints, higher levels of KZ index are associated with

lower cash flow sensitivity of cash. Our results in the last row of Table VI are consistent with these findings and suggest a possible explanation for them.

Specifically, based on KZ index, the least constrained firm-years in our sample are the high cash flow years for CF-sensitive firms. Indeed, we observe the highest investment-cash flow sensitivity for this sub-sample. Since our earlier results show that firms are virtually unconstrained in these periods, this evidence is consistent with the view that CF-sensitive firms overinvest in their high cash flow years.

In contrast, KZ index classifies CF-sensitive firms in their low cash flow years as the most constrained of the four sub-samples, demonstrating no sensitivity of investment to cash flows. This evidence is also consistent with our earlier results indicating that CF-sensitive firms face severe financial constraints in their low cash flow years. As reported earlier in Table III, CF-sensitive firms have an average cash flow of -0.089 in their low cash flow years. As we argued earlier, variations in cash flows that are at extremely low average levels are not likely to induce significant changes in firm investment levels.

Thus, our results imply that if the goal of an analysis is to identify firms that are likely to be financially constrained at the low points of their cash flow cycle, then the traditional criteria of sample separation, such as firm size, dividend payout or investment grade rated debt are more reliable indicators. If the goal of an analysis is to identify specific years in which firms are more constrained, then the KZ index is a more reliable indicator. Our results also show that, while we observe higher investment-cash flow sensitivity for firms that are more likely to face liquidity constraints, the sensitivity may primarily be generated in years when they are less constrained.

IV. Investment-Cash Flow Sensitivity and Firm Aggregate Investment

Our earlier results indicate that investment-cash flow sensitivity is associated with a statistically and economically significant redistribution of investment in time. Specifically, investment is abnormally low in low cash flow years and abnormally high in high cash flow

years. However, it is possible that "overinvestment" in high cash flow years simply reflects the current investment opportunities, as well as the investment opportunities foregone in low cash flow periods because of financial constraints. We test this hypothesis by examining whether investment-cash flow sensitivity affects aggregate firm-level investment.

A. Investment by Sensitivity Type

Table VII presents the average statistics describing the levels of investment and excess investment for CF-sensitive and CF-insensitive firms. The results show that CF-sensitive firms invest significantly more than CF-insensitive firms. The average capital expenditures are 0.349 and 0.239 for CF-sensitive and CF-insensitive firms, respectively. This result is not necessarily inconsistent with the notion that CF-sensitive firms may be financially constrained, since they also may have much higher growth opportunities as indicated by their higher market-to-book ratios in Table I.

Therefore, we also present the measures of excess investment we have defined in the previous section of the paper. Based on all measures of excess investment, CF-sensitive firms overinvest, while CF-insensitive firms underinvest. Controlling for industry and year effects, the excess investment of CF-sensitive firms is 0.050, implying that the normal investment of these firms is about fourteen percent lower than the observed average investment of 0.349. With an additional control for market-to-book, the excess investment drops to 0.044, which is still statistically and economically significant. When we consider net investment, the overinvestment drops in absolute value to 0.024 based on industry and year effects and to 0.019 based on industry, year, and market-to-book effects. Even with 0.019, however, the normal net investment would be about fourteen percent lower than the observed average net investment of 0.138.

B. Regressions of Time-Series Average Investment

An alternative way to assess the effect of investment-cash flow sensitivity on firm-level aggregate investment is to estimate a regression of average investment on the cash flow

sensitivity indicator and control variables for growth opportunities, as well as other firm characteristics that we earlier found to affect cash flow sensitivity. Also, measuring the average investment and the cash flow sensitivity over the same period of time creates problems with interpreting the statistical relation between the two and can bias our results. For example, since investment is censored at zero, a lower average investment over some period is likely to be associated with a lower variability in investment over the same period. This may create a mechanical positive association between average investment and investment-cash flow sensitivity in the same period.

To deal with this issue, we recalculate investment-cash flow sensitivity for each firm by applying equations (1) and (2) to rolling five-year intervals instead of the entire available time series of observations. Similarly, we calculate rolling five-year averages for all firm characteristics of interest. We then use these five-year averages to estimate regressions of investment on several sets of firm characteristics. In these regressions, the cash flow sensitivity indicator is based on the closest previous five-year time interval not overlapping with the current five-year stretch. For example, for the average investment calculated over 1991-1995, the corresponding firm characteristics such as average market-to-book are also calculated over 1991-1995. However, the cash flow sensitivity is calculated for the 1986-1990 period. By calculating the cash flow sensitivity over a period not overlapping with the period of investment, we remove the potential source of a mechanical relation between the two.[21]

Table VIII presents the coefficient estimates for three different specifications of the investment regression along with the 95 percent confidence intervals for these estimates. Because the observations in the regressions are based on overlapping five-year time intervals, the OLS standard errors are not usable. The reported statistics are based on 500 bootstrap replications re-

sampled from our dataset with replacement of clusters. Clusters are formed from observations belonging to the same firm. The 95 percent confidence interval is obtained from the sample of 500 bootstraped coefficient estimates.

The first set of results shows that five-year average investment is significantly positively related to investment-cash flow sensitivity. The effect is economically significant. CF-sensitive firms' investment rates are about 37.4 percent higher than the investment rates of CF-insensitive firms. In the second regression, we add average market-to-book and average cash flow as controls for investment opportunities. The effect of cash flow sensitivity remains significantly positive. In the third regression, we include industry investment as an additional control for investment opportunities and all the predictors of the cash flow sensitivity status from our Table II as controls for factors that could indirectly induce a positive relation between investment and cash flow sensitivity. The results demonstrate that the positive relation between investment and investment-cash flow sensitivity is robust to the inclusion of these controls. In other words, CF-sensitive firms overinvest rather than underinvest, as we might expect for firms that are traditionally described as financially constrained.

C. Robustness of the Results

In an earlier study, Minton and Schrand (1999) report that the average investment of firms with high volatility of cash flows is lower than that of firms with low volatility. They conclude that, in the presence of financial constraints, cash flow volatility reduces the aggregate firm-level investment. There are a number of differences between our studies. Minton and Schrand (1999) use quarterly data from 1989 to 1995. Our data is annual and covers 1985 through 2003. More importantly, there are also significant methodological differences. Minton and Schrand (1999) use operating cash flows, scale capital expenditures and cash flows by total

[21] We should note that the results were qualitatively similar when we used cash flow sensitivity measured over the same five-year period as the investment or when the regressions in Table VII were estimated using

assets, use the book-to-market ratio to measure growth opportunities, use the coefficient of variation of unscaled cash flows as the measure of volatility, and estimate their regressions using industry-adjusted values of all of their variables.

The tradition in the investment-cash flow sensitivity literature is to scale capital expenditures and cash flows by net fixed assets (see, e.g., Fazzari, Hubbard, and Petersen (1988), Kaplan and Zingales (1997)) since capital expenditures represent investment in fixed assets. Similarly, the traditional measure of cash flow is the income before extraordinary items plus depreciation and amortization. Growth opportunities are traditionally measured by Tobin's Q. We follow Kaplan and Zingales (1997) and use market-to-book ratio of assets as a proxy for Tobin's Q. Finally, while Minton and Schrand (1999) examine the effect of cash flow volatility on investment, we use a direct measure of investment-cash flow sensitivity and examine its impact on aggregate firm-level investment.

To see whether our results are robust, we re-estimate our regressions in Table VIII making several alternative methodological choices.[22] First, we rescale our investment and cash flow variables by total assets instead of net fixed assets. Second, we replace our cash flow measure with operating cash flow, our measure of cash flow volatility (standard deviation of scaled cash flows) with the coefficient of variation of unscaled cash flows, and the market-to-book ratio with book-to-market, as in Minton and Schrand (1999). None of these changes affect our qualitative results. Third, we estimate investment regressions using specifications based on equations (2) and (3) from Minton and Schrand (1999). We find that in our sample, the effect of cash flow volatility on investment is either significantly positive or insignificant, depending on the particular specification. However, when we restrict the sample period to 1989-1995, the effect of cash flow volatility is always insignificant. Finally, when we add our cash flow sensitivity

averages based on the entire available time series of firm-level observations.

[22] For brevity, we do not report these results but they are available upon request.

indicator into Minton and Schrand (1999) regressions (2) and (3), we find its effect to be significantly positive, which is consistent with our results in Table VIII.

D. Discussion of the Results

The aggregate firm-level overinvestment by CF-sensitive firms implies that financial constraints are not the only factor that affects corporate investment. Traditionally, corporate finance literature links overinvestment to agency problems. According to Jensen (1986), managers would rather invest in negative NPV projects than pay out the free cash flow to investors. More recently, a number of studies relate overinvestment to such behavioral phenomenon as CEO overconfidence (Malmendier and Tate (2005)). Overconfident CEOs overestimate their ability to generate positive NPV projects and give little weight to the market's view about the firm's investment opportunities in their investment decisions.

While a formal test of the agency and behavioral explanations of our findings is beyond the scope of this paper, it seems difficult to explain our findings by agency problems only. Specifically, it is not clear why managers bent on investing every available dollar of cash would save a significant portion of that cash in periods when financial constraints are not binding in order to finance investment in future periods when constraints are more severe. Such behavior suggests a difference of opinion between the market and managers not only about the amount of investment to be undertaken but also about its timing.

V. Conclusion

This paper uses a novel empirical approach to estimate the sensitivity of investment expenditures to internally generated cash flow on individual firm level. Our approach allows us to examine previously unexplored aspects of the investment-cash flow sensitivity issue.

Our findings indicate that the observed investment-cash flow sensitivity is not a purely statistical phenomenon. Firms demonstrating higher investment-cash flow sensitivity are more

likely to face liquidity constraints. However, their internal and external liquidity, as well as their investment and financing behavior, vary significantly across periods of low and high cash flows.

In particular, these firms are severely financially constrained in years when their cash flows are low. Financing is scarce not only because of lower internal liquidity but also lower market-to-book ratios and higher leverage, which make external capital more costly. Thus, the effect of cash flow shortfalls on investment expenditures is compounded by the fact that external capital is significantly less accessible in low cash flow years. As a result, these firms significantly underinvest compared to their industry peers and firms with lower investment-cash flow sensitivity. The span of an average period of low liquidity is 3 to 4 years, which implies about the possibility of significant economic losses.

In high cash flow years, the same firms appear to be virtually financially unconstrained. They enjoy significant internal liquidity combined with much easier access to financial markets. As a result, these firms issue significant amounts of debt and equity, although their internally generated cash flows far exceed their investment expenditures. Having ample resources, they are able to overinvest. They also build up their financial slack and net working capital to abnormally high levels in anticipation of less favorable liquidity conditions in the future, when these sources will be drained down to abnormally low levels.

The observed patterns of financing and investment imply that managers consider it costly to delay investments that they would like to undertake in years of tight financial constraints. They actively counteract the effects of variations in cash flow on investment as they try to smooth it by taking advantage of temporary releases in financial constraints in high cash flow years. While it is still likely that the variations in cash flows reflect variations in marginal growth opportunities among other things, the observed firm behavior is very hard to explain without invoking financial constraints. Our empirical approach also allows us to conclude that the cross-sectional variation

in investment-cash flow sensitivity cannot be fully driven by the cross-sectional variation in the measurement error of marginal *Q*.

Our analysis also shows that firms with higher investment-cash flow sensitivity have characteristics that are traditionally associated with tighter financial constraints, such as smaller size, lower likelihood of paying dividends or having debt rating, higher financial slack and higher growth opportunities. Among these indicators, size, dividend payout and debt rating, most often used for distinguishing firms with financial constraints, seem to be less successful for distinguishing between periods of high and low liquidity, since they show insignificant variation across the cash flow cycle of a firm. These periods are much more clearly separated by the KZ index, another indicator of the severity of financial constraints used in the current literature, which, on the other hand, is less successful in identifying firms that are likely to face liquidity constraints.

Finally, we find that even though financial constraints limit investment in low cash flow years, firms more than compensate for that by overinvesting in high cash flow years. As a result, firms with higher investment-cash flow sensitivity, on average, overinvest rather than underinvest. However, it remains a question to be answered in future research whether the aggregate overinvestment reflects managerial incentives to overinvest or it reflects CEO overconfidence.

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Table I

Average Firm Characteristics by Investment-Cash Flow Sensitivity Type

Investment-cash flow sensitivity is measured as the difference between cash-flow-weighted average and arithmetic average investment. Firms are classified as CF-sensitive if the cash flow sensitivity based on concurrent cash flows (CFSI(0)) or lagged cash flows (CFSI(-1)) is greater than 0.05. The reported means for all variables except standard deviations are cross-sectional averages of time-series averages for individual firms. Investment is capital expenditures scaled by lagged net capital. Dividend payout indicator is set to 1 if a firm pays dividends. Leverage is the sum of short-term and long-term debt divided by total assets. Industry-adjusted leverage is leverage minus the mean leverage of firms in the same industry as defined by the two-digit SIC code. Speculative and investment grade rating indicators are set to 1 if a firm has, respectively, a speculative or investment grade rating from S&P. Asset tangibility is net capital divided by total assets. Financial slack is cash and marketable securities over net capital. Cash flow is (earnings before extraordinary items + depreciation) over lagged net capital. Market-to-book is (total assets – book value of equity – deferred taxes + market value of equity) / total assets. Sales growth is the change in sales over lagged sales. Asset growth is the change in assets over lagged assets. The standard deviation of cash flow is the cross-sectional average of individual time-series standard deviations. Values for CF-sensitive firms that are different from those for CF-insensitive firms at the 1% level of significance are marked **.

	CF-insensitive	CF-sensitive
CFSI(0)	-0.003	0.132**
CFSI(-1)	0.001	0.121**
CF-sensitivity (regression estimate)	-0.001	0.101**
Investment	0.244	0.387**
Sales (in million $)	1308.0	399.8**
Dividend payout indicator	0.401	0.130**
Leverage	0.281	0.259**
Industry adjusted leverage	0.008	0.011
Speculative grade rating indicator	0.108	0.112
Investment grade rating indicator	0.147	0.021**
Asset tangibility	0.374	0.293**
Financial slack	0.757	1.238**
Cash flow	0.328	0.274**
Market-to-book	1.521	1.688**
Sales growth	0.113	0.150**
Asset growth	0.113	0.141**
Firm-level standard deviation of CF	0.329	0.770**
Observations	4,169	3,007

Table II

Probit Regression of Determinants of Investment-Cash Flow Sensitivity

Investment-cash flow sensitivity is measured as the difference between cash-flow-weighted average and arithmetic average investment. Firms are classified as CF-sensitive if the cash flow sensitivity based on concurrent cash flows (CFSI(0)) or lagged cash flows (CFSI(-1)) is greater than 0.05. The dependent variable equals 1 for CF-sensitive firms. All firm characteristics are time series averages based on all observations available for a firm. Size is the natural log of sales. Dividend payout indicator is set to 1 if a firm pays dividends. Leverage is the sum of short-term and long-term debt divided by total assets. Industry leverage is the mean leverage of firms in the same industry as defined by the two-digit SIC code. Speculative and investment grade rating indicators are set to 1 if a firm has, respectively, a speculative or investment grade rating from S&P. Asset tangibility is net capital divided by total assets. Financial slack is cash and marketable securities over net capital. Cash flow is (earnings before extraordinary items + depreciation) over lagged net capital. Low, medium, and high CF indicators are set to 1, respectively, for the bottom, medium, and top thirds of the distribution of firm-level average cash flows. Market-to-book is (total assets – book value of equity – deferred taxes + market value of equity) / total assets. The standard deviation of cash flow is the cross-sectional average of individual time-series standard deviations. Robust z-statistics reflect standard errors adjusted for heteroskedasticity. Coefficient estimates significantly different from zero at 5% and 1% level are marked * and **, respectively.

	Coeff.	z-stat.
Intercept	-0.053	-0.5
Market-to-book	0.064**	2.7
Size	-0.010	-0.8
Dividend payout indicator	-0.703**	-14.7
Leverage	-0.151	-1.4
Industry leverage	-0.891**	-3.5
Speculative rating indicator	0.155*	2.2
Investment grade indicator	-0.873**	-8.4
Tangibility	0.075	0.7
Financial slack	-0.054**	-4.4
Cash flow × low CF indicator	0.888**	9.4
Cash flow × medium CF indicator	-0.178	-1.2
Cash flow × high CF indicator	-0.187**	-4.3
Firm-level standard deviation of CF	0.864**	13.1
Pseudo-R^2	0.164	
Observations (CF-sensitive)	3,007	
Observations (CF-insensitive)	4,169	

Table III

Investment across the Cash Flow Cycle by Investment-Cash Flow Sensitivity Type

Investment-cash flow sensitivity is measured as the difference between cash-flow-weighted average and arithmetic average investment. Firms are classified as CF-sensitive if the cash flow sensitivity based on concurrent cash flows (CFSI(0)) or lagged cash flows (CFSI(-1)) is greater than 0.05. A year is defined as low (high) cash flow if the cash flow-based weight in equation (1) is less (greater) than (1/n), where n is the number of observations in the firm's time series. Cash flow is (earnings before extraordinary items + depreciation) over lagged net capital. Investment is capital expenditures scaled by lagged net capital. Net investment is the change in net capital over lagged net capital. Asset growth is the change in assets over lagged assets. Sales growth is the change in sales over lagged sales. Excess value (industry, year) is the difference between the value of the firm characteristic and the average value for firms in the same year and industry (based on the two-digit SIC code). Excess value (industry, year, MB) is the residual of a cross-sectional regression of the firm characteristic on market-to-book ratio estimated separately for each year and industry. Spell length is the average length in year of low and high cash flow periods excluding truncated cases. Values significantly different from zero at 5% and 1% level are marked * and **, respectively. High cash flow year values significantly different from low cash flow year values at 5% and 1% level are marked ^{x} and ^{xx}, respectively.

	CF-insensitive		CF-sensitive	
High vs. low cash flow years	Low	High	Low	High
Cash flow	0.165**	0.582**^{xx}	-0.089**	0.944**^{xx}
Investment	0.210**	0.269**^{xx}	0.238**	0.507**^{xx}
Excess investment (industry, year)	-0.048**	-0.003^{xx}	-0.050**	0.191**^{xx}
Excess investment (industry, year, MB)	-0.034**	-0.012**^{xx}	-0.037**	0.160**^{xx}
Net investment	0.046**	0.156**^{xx}	0.003	0.330**^{xx}
Excess net investment (industry, year)	-0.057**	0.033**^{xx}	-0.097**	0.198**^{xx}
Excess net investment (industry, year, MB)	-0.043**	0.024**^{xx}	-0.083**	0.165**^{xx}
Asset growth	0.055**	0.179**^{xx}	0.007*	0.298**^{x}
Excess asset growth (industry, year)	-0.055**	0.050**^{xx}	-0.102**	0.160**^{xx}
Excess asset growth (industry, year, MB)	-0.041**	0.039**^{xx}	-0.088**	0.131**^{xx}
Sales growth	0.055**	0.158**^{xx}	0.034**	0.271**^{xx}
Excess sales growth (industry, year)	-0.048**	0.035**^{xx}	-0.073**	0.136**^{xx}
Excess sales growth (industry, year, MB)	-0.038**	0.028**^{xx}	-0.063**	0.114**^{xx}
Spell length	3.892**	3.844**^{xx}	3.984**	3.436**^{xx}
Observations	20,060	19,692	12,042	8,491

Table IV

External Financing across the Cash Flow Cycle by Investment-Cash Flow Sensitivity Type

Investment-cash flow sensitivity is measured as the difference between cash-flow-weighted average and arithmetic average investment. Firms are classified as CF-sensitive if the cash flow sensitivity based on concurrent cash flows (CFSI(0)) or lagged cash flows (CFSI(-1)) is greater than 0.05. A year is defined as low (high) cash flow if the cash flow-based weight in equation (1) is less (greater) than (1/n), where n is the number of observations in the firm's time series. Net equity issued is the difference between equity issued and equity repurchased, scaled by net capital. Net debt issued is the change in the book value of long-term and short-term debt scaled by net capital. Market-to-book is the (total assets – book value of equity – deferred taxes + market value of equity) / total assets. Industry-adjusted market-to-book is market-to-book minus the mean two-digit SIC industry market-to-book. CAR is the three-day cumulative abnormal return around the announcement of a seasoned equity offering. Leverage is the sum of short-term and long-term debt divided by total assets. Industry-adjusted leverage is leverage minus the mean industry leverage. Values significantly different from zero at 5% and 1% level are marked * and **, respectively. High cash flow year values significantly different from low cash flow year values at 5% and 1% level are marked ^{x} and ^{xx}, respectively.

	CF-insensitive		CF-sensitive	
High vs. low cash flow years	Low	High	Low	High
Panel A: Equity Financing				
Equity issued	0.033**	0.067**^{xx}	0.091**	0.313**^{xx}
Market-to-book	1.399**	1.660**^{xx}	1.494**	1.930**^{xx}
Change in market-to-book (-2 to –1)	-0.074**	0.018**^{xx}	-0.201**	0.056**^{xx}
Industry Adjusted Market-to-book	-0.153**	0.073**^{xx}	-0.174**	0.221**^{xx}
CAR	-0.027**	-0.029**	-0.040**	-0.033**
Panel B: Debt Financing				
Debt issued	0.088**	0.169**^{xx}	0.060**	0.290**^{xx}
Leverage (-1)	0.284**	0.248**^{xx}	0.273**	0.221**^{xx}
Industry Adjusted Leverage (-1)	0.010**	-0.020**^{xx}	0.025**	-0.021**^{xx}
Industry Adjusted Leverage (0)	0.013**	-0.025**^{xx}	0.032**	-0.024**^{xx}
Observations	20,060	19,692	12,042	8,491

Table V

Internal Liquidity across the Cash Flow Cycle by Investment-Cash Flow Sensitivity Type

Investment-cash flow sensitivity is measured as the difference between cash-flow-weighted average and arithmetic average investment. Firms are classified as CF-sensitive if the cash flow sensitivity based on concurrent cash flows (CFSI(0)) or lagged cash flows (CFSI(-1)) is greater than 0.05. A year is defined as low (high) cash flow if the cash flow-based weight in equation (1) is less (greater) than (1/n), where n is the number of observations in the firm's time series. Financial slack is cash and marketable securities over net capital. NWC is the net working capital excluding short-term debt. Excess (change in) value is the residual of a cross-sectional regression of the firm characteristic on (change in) sales estimated separately for each year and two-digit SIC industry. Values significantly different from zero at 5% and 1% level are marked * and **, respectively. High cash flow year values significantly different from low cash flow year values at 5% and 1% level are marked ^{x} and ^{xx}, respectively.

	CF-insensitive		CF-sensitive	
High vs. low cash flow years	Low	High	Low	High
Change in slack	0.001	0.070**^{xx}	-0.012*	0.150**^{xx}
Change in NWC	0.008	0.230**^{xx}	-0.086**	0.487**^{xx}
Excess change in slack	-0.026**	0.026**^{xx}	-0.044**	0.067**^{xx}
Excess change in NWC	-0.048**	0.060**^{xx}	-0.121**	0.147**^{xx}
Excess slack	-0.090**	-0.003^{xx}	-0.008	0.235**^{xx}
Excess NWC	-0.082**	-0.028^{xx}	-0.005	0.268**^{xx}
Observations	20,060	19,692	12,042	8,491

Table VI

Indicators of Financial Constraints across the Cash Flow Cycle

Investment-cash flow sensitivity is measured as the difference between cash-flow-weighted average and arithmetic average investment. Firms are classified as CF-sensitive if the cash flow sensitivity based on concurrent cash flows (CFSI(0)) or lagged cash flows (CFSI(-1)) is greater than 0.05. A year is defined as low (high) cash flow if the cash flow-based weight in equation (1) is less (greater) than (1/n), where n is the number of observations in the firm's time series. KZ index equals -1.002 * (cash flow / lagged net capital) + 0.283 * (market-to-book) + 3.139 * (long-term and short-term debt / total assets) – 39.368 * (dividends / lagged net capital) – 1.315 * (slack / lagged net capital). Cash flow is (earnings before extraordinary items + depreciation) over lagged net capital. High cash flow year values significantly different from low cash flow year values at 5% and 1% level are marked ^{x} and ^{xx}, respectively. CF-sensitive values significantly different from CF-insensitive values at 5% and 1% level are marked ^{y} and ^{yy}, respectively. Regression estimates of CF-sensitivity significantly different from zero at 5% and 1% level are marked * and **, respectively.

	CF-insensitive		CF-sensitive	
High vs. low cash flow years	Low	High	Low	High
Sales (in million $)	1,867.7	1,968.4	511.9^{yy}	485.2^{yy}
Dividend payout indicator	0.511	0.532	0.156^{yy}	0.178^{yy}
Investment grade rating indicator	0.204	0.225^{xx}	0.027^{yy}	0.034^{xyy}
KZ index	-1.092	-2.181^{xx}	-0.496^{yy}	-2.391^{xx}
CF-sensitivity (regression estimate)	-0.012**	0.066**	0.000	0.270**
Observations	20,060	19,692	12,042	8,491

Table VII

Average Investment by Investment-Cash Flow Sensitivity Type

Investment-cash flow sensitivity is measured as the difference between cash-flow-weighted average and arithmetic average investment. Firms are classified as CF-sensitive if the cash flow sensitivity based on concurrent cash flows (CFSI(0)) or lagged cash flows (CFSI(-1)) is greater than 0.05. Investment is capital expenditures scaled by lagged net capital. Net investment is change in net capital over lagged net capital. Excess value (industry, year) is the difference between the value of the firm characteristic and the average value for firms in the same year and industry (based on a two-digit SIC code). Excess value (industry, year, MB) is the residual of a cross-sectional regression of the firm characteristic on market-to-book ratio estimated separately for each year and industry. Values significantly different from zero at 5% and 1% level are marked * and **, respectively. CF-sensitive firm values significantly different from CF-insensitive firm values at 5% and 1% level are marked ^{x} and ^{xx}, respectively.

	CF-insensitive	CF-sensitive
Investment	0.239**	0.349**^{xx}
Excess Investment (industry, year)	-0.026**	0.050**^{xx}
Excess Investment (industry, year, MB)	-0.023**	0.044**^{xx}
Net investment	0.101**	0.138**^{xx}
Excess Net Investment (industry, year)	-0.012**	0.024**^{xx}
Excess Net Investment (industry, year, MB)	-0.010**	0.019**^{xx}
Observations	39,752	20,533

Table VIII

Cross-Section Regressions of Firm-Level Time-Series Average Investment on Time-Series Averages of Firm Characteristics

Investment is capital expenditures scaled by lagged net capital. Industry investment is the mean investment of firms in the same industry as defined by a two-digit SIC code. Cash flow is (earnings before extraordinary items + depreciation) over lagged net capital. Investment-cash flow sensitivity is measured as the difference between cash-flow-weighted average and arithmetic average investment. Firms are classified as CF-sensitive if the cash flow sensitivity based on concurrent cash flows (CFSI(0)) or lagged cash flows (CFSI(-1)) is greater than 0.05. Market-to-book is (total assets – book value of equity – deferred taxes + market value of equity) / total assets. Size is the log of sales. Dividend payout indicator is set to 1 if a firm pays dividends in a particular year. Leverage is the sum of short-term and long-term debt divided by total assets. Industry leverage is the mean leverage of firms in the same industry as defined by a two-digit SIC code. Speculative and investment grade rating indicators are set to 1 if a firm has, respectively, a speculative or an investment grade rating from S&P. Asset tangibility is net capital divided by total assets. Financial slack is cash and marketable securities over net capital. The standard deviation of cash flow is the cross-sectional average of individual time-series standard deviations. The reported statistics are based on 500 bootstrap replications re-sampled from our dataset with replacement of clusters. Clusters are formed from observations belonging to the same firm. Values significantly different from zero at 5% are marked *.

	Observed	95% Conf. Interval		Observed	95% Conf. Interval		Observed	95% Conf. Interval	
Intercept	0.219*	0.214	0.224	0.113*	0.101	0.125	-0.035	-0.079	0.009
CF-sensitivity indicator	0.082*	0.069	0.094	0.071*	0.061	0.082	0.033*	0.023	0.042
Cash flow				0.130*	0.109	0.150	0.121*	0.099	0.143
Market-to-book				0.039*	0.029	0.050	0.026*	0.018	0.034
Size							0.007*	0.004	0.010
Dividend dummy							-0.027*	-0.038	-0.016
Leverage							-0.095*	-0.123	-0.066
Industry leverage							0.080	-0.015	0.175
Speculative grade indicator							0.006	-0.010	0.021
Investment grade indicator							-0.025*	-0.036	-0.013
Tangibility							0.076*	0.051	0.101
Financial slack							-0.006	-0.015	0.004
σ(CF)							0.081*	0.062	0.100
Industry investment							0.385*	0.330	0.440
R-sq	0.051			0.306			0.437		
Obs	14,733			14,733			14,733		
Clusters	2,468			2,468			2,468		