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Investment and Cash Flow: New Evidence

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Abstract

We study the investment–cash flow sensitivities of U.S. firms from 1971–2009. Our tests extend the literature in several key ways and provide strong evidence that cash flow explains investment beyond its correlation with q. A dollar of current- and prior-year cash flow is associated with \$0.32 of additional investment for firms that are the least likely to be constrained and \$0.63 of additional investment for firms that are the most likely to be constrained, even after correcting for measurement error in q. Our results suggest that financing constraints and free-cash-flow problems are important for investment decisions.

I. Introduction

The interaction between investment and financing decisions is arguably the central issue in corporate finance. It is now well established that a firm's financing choices may affect its investment decisions because taxes, issuance costs, agency conflicts, and information problems associated with debt and equity will affect the firm's cost of capital, drive a wedge between the cost of internal and external funds, and alter managers' incentives to take different types of projects.

An issue that has received particular attention is the sensitivity of investment to internally generated cash flow. Theoretically, a firm might invest more when cash flow is high for three reasons: i) internal funds may be less costly than external funds, ii) managers may overspend internally available funds, and iii) cash flow may simply be correlated with investment opportunities.

Empirically, investment and cash flow are indeed related, although both the strength of the relation and its cause are the subject of much debate. For example, Fazzari, Hubbard, and Petersen (1988) and Kaplan and Zingales (1997) estimate investment–cash flow sensitivities of 0.20–0.70 for manufacturing firms

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from 1970–1984, significant even for firms that do not appear to be financially constrained. Cleary (1999) and Baker, Stein, and Wurgler (2003) report substantially lower values of 0.05–0.15, the former for a sample of 1,317 surviving firms from 1988–1994 and the latter for a large unbalanced panel from 1980–1999. Rauh (2006) estimates an investment–cash flow sensitivity of 0.11 from 1990–1998 but also finds that firms cut investment by $0.60–0.70 in response to a dollar of mandatory pension contributions. More recently, Hennessy, Levy, and Whited (2007), Almeida, Campello, and Galvao (2010), and Erickson and Whited (EW) (2012) estimate investment–cash flow sensitivities of just 0.01–0.09, whereas Chen and Chen (2012) find that investment–cash flow sensitivities have "completely disappeared in recent years" (p. 394). In short, although there remains disagreement about why investment and cash flow are related, much of the recent literature suggests that cash flow has, at most, a small impact on investment.

This paper provides new evidence on the link between investment and cash flow. Our tests offer a number of methodological contributions that substantially improve estimates of investment–cash flow sensitivities and, as it turns out, dramatically strengthen the apparent impact of cash flow on investment. Specifically, our tests extend the literature in five keys ways:

i) We introduce a new measure of cash flow that is significantly better than the measure commonly used in the literature (income before extraordinary items plus depreciation). The standard measure has become noisier over time because it incorrectly reflects a variety of noncash expenses, such as asset write-downs and deferred taxes, that have become more important in recent years. We show that correcting for these noncash items, using data widely available on Compustat, significantly increases the investment–cash flow sensitivities estimated in our sample (1971–2009).

ii) We employ several new instrumental variable (IV) estimators to correct for measurement error in a firm's market-to-book ratio (MB), our proxy for q. Our IVs address limitations of existing estimators. For example, most IV estimators in the literature are based on lagged MB and, as EW (2012) note, are valid only if serial correlation in measurement error is small or short-lived. We use several alternative instruments, including lagged returns and lagged cash flow, to get around this concern. An alternative approach used in the literature, the EW higher-moment estimator, also addresses the serial correlation issue. However, it "can be applied only to samples that are arguably i.i.d." (EW), an assumption clearly violated in both time-series and cross-sectional data, and can give very imprecise estimates when applied to particular years of the sample, requiring tests to give disproportionately large or small weight to different years when aggregating the results (via the EW minimum-distance approach). We show that one of our IV estimators is valid under weaker assumptions than those in the EW approach and delivers precise estimates even when all years of the sample are weighted equally. Of course, our instruments may not be perfect, but we argue that our results may well be conservative if the identifying assumptions are violated. Our tests provide a powerful and straightforward alternative to existing methods in the literature.

iii) We study how investment relates to both current and lagged cash flow. The contemporaneous link between investment and cash flow is studied extensively in the literature but can miss a substantial part of the total effect if investment decisions are implemented slowly or if investment reacts to changes in expected cash flow (which is highly correlated with lagged cash flow). In fact, investment is more strongly related to lagged than to current cash flow, and adding lagged cash flow to the regressions significantly raises estimates of investment–cash flow sensitivities.

iv) We study all of the ways firms spend cash flow, not just their capital expenditures. Firms might use cash flow in seven basic ways: to increase cash holdings; to invest in working capital; to buy property, plant, and equipment (PPE) and other fixed assets; to acquire other firms; to pay down debt; to repurchase shares; or to pay dividends. We simultaneously track all seven uses in order to provide a complete picture of what firms do with cash flow. Prior studies have looked at specific components in isolation, but, to our knowledge, ours is the first to provide a full accounting of the use of cash flow.[1]

v) We offer a new way to sort firms into financially constrained and unconstrained groups based on forecasts of a firm's free cash flow. Our goal here is more to identify unconstrained firms with lots of excess cash than to identify firms that are unambiguously constrained. In the 3 years leading up to the sort, the unconstrained group has high and increasing sales, profits, cash flow, returns, and cash holdings but low and decreasing debt and investment. Cash flow exceeds capital expenditures by an average of 11.5% of asset value and exceeds total investment by 2.1% of asset value. By the year of the sort, the firms' cash holdings and net working capital (NWC) exceed their total liabilities, and the firms could pay down debt with just over 1 year of cash flow. This group allows us to explore investment–cash flow sensitivities for firms that, by all appearances, seem to be financially unconstrained.

Our results suggest that investment and cash flow are strongly linked after controlling for a firm's investment opportunities. For the full sample of firms, basic ordinary least squares (OLS) investment regressions (with no correction for measurement error in q) show that an additional dollar of cash flow is associated with an extra \$0.14 of working capital, \$0.26 of capital expenditures, and \$0.35 of total long-term investment, with the remainder split fairly evenly between additions to cash holdings (\$0.15), reductions in debt (\$0.13), share repurchases (\$0.13), and dividends (\$0.06). (The effects, all highly significant, sum to slightly less than 1 because of so-called "dirty surplus" accounting.) The prior year's cash flow is even more strongly related to investment; together, an additional dollar of cash flow in the current and prior year is associated with an extra \$0.60 of total investment. These cash flow effects are much stronger than those found in the recent literature, due in part to the data refinements discussed earlier.

Interestingly, lagged cash flow is significant even when controlling for a firm's beginning-of-year cash holdings and debt, suggesting that it picks up more than a direct financial constraint effect (i.e., lagged cash flow does not just work

[1]A recent paper by Gatchev, Pulvino, and Tarhan (2010) takes a step in this direction, but because of how they measure investment, financing, and cash flow, their tests appear to track only a portion of what firms do with cash flow. For example, the slopes in their "unconstrained" regressions suggest that their variables capture roughly 60% to 80% of a firm's cash expenditures (see their Table V, columns (1) and (3)).

through its effects on a firm's cash and debt positions). One interpretation is that high prior-year cash flow raises managers' expectation of current cash flow, and it is this expected, rather than total, cash flow that drives investment. In fact, our estimates suggest that a dollar of expected cash flow leads to \$0.68 of additional fixed investment, compared to just \$0.12 for a dollar of unexpected cash flow. Further, unexpected cash flow is largely used to reduce debt (−\$0.47), whereas higher expected cash flow actually leads to more borrowing (+\$0.09). The latter finding suggests some complementarity between internal funds and debt, consistent with the multiplier effects discussed by Almeida and Campello (2007) and Hennessy et al. (2007).

Splitting the sample into constrained and unconstrained firms reveals significant differences between the two groups. Consistent with prior studies, capital expenditures for both groups react strongly to cash flow: capital expenditures increase by \$0.28 for unconstrained firms and \$0.41 for constrained firms when current cash flow increases by a dollar. However, total investment expenditures, including spending on working capital and all types of fixed assets, increases by \$0.72 for constrained firms, more than double our estimate of \$0.30 for unconstrained firms. The flip-side of this result is that constrained firms pay out just \$0.11 of each dollar of cash flow compared to \$0.50 for unconstrained firms. These disparities are largely driven by the groups' differential response to unexpected cash flow.

A sizable fraction of the link between investment and cash flow can be attributed to measurement error in q, but we strongly reject the joint hypothesis that investment is linear in q and cash flows are important only because MB measures q with error. Focusing on total fixed investment, the slope on current-year cash flow drops from 0.29 to −0.05 for unconstrained firms and from 0.53 to 0.45 for constrained firms after we correct for measurement error in MB. The slope on prior-year cash flow drops from 0.53 to 0.37 for unconstrained firms and from 0.47 to 0.45 for constrained firms. Thus, measurement error in q can explain a large portion of the investment–cash flow sensitivity of unconstrained firms but little of the investment–cash flow sensitivity of constrained firms. A key open question is whether the remaining effect among unconstrained firms reflects lingering constraints or violations of the standard q model, for example, caused by agency problems. At a minimum, the higher investment–cash flow sensitivity among firms that are the most likely to be constrained strongly suggests that financing constraints play an important role.

The remainder of the paper is organized as follows: Section II reviews q theory, Section III describes the data, Section IV reports OLS investment regressions, Section V explores the impact of measurement error in q, and Section VI concludes.

II. *Q* Theory

We begin with a quick review of q theory as background for our tests. The value of a firm is given by the present value of its expected payouts, equal to profits $\Pi(K_t, s_t)$, a function of the beginning-of-period capital stock K_t and a state variable s_t, minus new investment, I_t, and adjustment costs associated with investment, $C(I_t, K_t, \lambda_t)$. Adjustment costs depend on the existing scale of the firm and an exogenous stochastic parameter, λ_t. Expressed in recursive form, the value of the firm is

$$V_t = \Pi(K_t, s_t) - I_t - C(I_t, K_t, \lambda_t) + \beta \mathrm{E}_t[V_{t+1}]. \tag{1}$$

For simplicity, we assume the discount factor β is constant and the state variables s_t and λ_t are Markov processes (negative payouts are interpreted as external financing). Capital depreciates through time at a rate δ and evolves according to $K_{t+1} = (1-\delta)K_t + I_t$. If we write the value function as $V_t = V(K_t, s_t, \lambda_t)$, the first-order condition for value maximization is

$$1 + C_I(I_t, K_t, \lambda_t) = \beta \mathrm{E}_t[V_K(K_{t+1}, s_{t+1}, \lambda_{t+1})], \tag{2}$$

where C_I and V_K denote partial derivatives. The left-hand side is the marginal cost of investment, and the right-hand side is marginal q, the present value of an additional dollar of capital. To make this equation concrete for empirical tests, adjustment costs are typically assumed to be quadratic in I_t/K_t, for example:

$$C = 0.5\alpha \left(\frac{I_t}{K_t} - \lambda_t \right)^2 K_t, \tag{3}$$

implying that $C_I = \alpha(I_t/K_t - \lambda_t)$. Substituting into equation (2), and denoting the right-hand side simply as q_t, the optimal investment rate becomes linear in q:

$$\frac{I_t}{K_t} = -\frac{1}{\alpha} + \frac{1}{\alpha} q_t + \lambda_t. \tag{4}$$

The most common empirical proxy for q is some form of MB ratio for assets or capital. In truth, MB is likely to be a better measure of average than marginal q, but Hayashi (1982) shows that the two are equal if the firm has constant returns to scale and is a price taker in both input and output markets.

If λ_t is unobservable noise, equation (4) can be interpreted as a regression, with two main implications: i) investment depends solely on q_t, and ii) the slope on q_t should be determined by the adjustment-cost parameter α. These implications represent the traditional starting point for thinking about investment in a world without financial frictions. The first point, in particular, says that investment should be unrelated to cash flow, or any other measure of net worth or liquidity, after controlling for q.

On the other hand, cash flow might be important if the firm faces financing constraints, shorthand for saying that external funds are more costly than internal funds. For example, suppose that external financing costs are quadratic in the spread between investment and profits (this is not quite equal to the amount of capital raised because it ignores adjustment costs, but it should capture the first-order effects pretty well):

$$\mathrm{FC}_t = 0.5b \left(\frac{I_t}{K_t} - \frac{\Pi_t}{K_t} \right)^2 K_t, \quad \text{if} \quad I_t > \Pi_t, \tag{5}$$

for some parameter $b \geq 0$. If we include this cost in equation (1), and keep all other assumptions the same, the first-order condition for value maximization becomes

$$(6) \qquad 1+\alpha\left(\frac{I_t}{K_t}-\lambda_t\right)+b\left(\frac{I_t}{K_t}-\frac{\Pi_t}{K_t}\right) \quad = \quad q_t,$$

when $I_t > \Pi_t$ and remains unchanged if $I_t \leq \Pi_t$. Rearranging equation (6) yields:

$$(7) \qquad \frac{I_t}{K_t} \quad = \quad -\frac{1}{\alpha+b}+\frac{1}{\alpha+b}q_t+\frac{b}{\alpha+b}\frac{\Pi_t}{K_t}+\frac{\alpha}{\alpha+b}\lambda_t.$$

Thus, with financing costs, the coefficient on q_t drops, and profit directly enters the investment equation. Our regressions can be interpreted as a test of whether b is greater than 0. The key empirical challenge comes from the fact that when q is measured with error, profits may appear to be important even if $b=0$, assuming that profits themselves are correlated with q.

III. Data

Our tests use all nonfinancial firms on Compustat, merged with returns from the Center for Research in Security Prices (CRSP). Firms in a given year must have data for both returns and "net" assets, the latter defined as total assets minus nondebt current liabilities. In addition, to ensure that small stocks do not drive the results, we drop firms smaller than the New York Stock Exchange (NYSE) 10th percentile measured by net assets at the beginning of the year.[2]

A. Variable Definitions

The tests require data on a firm's cash flow, investments, and financing choices. We start with the following accounting identities:

$$(8) \quad \text{NET\_ASSETS} \quad = \quad \text{CASH}+\text{NWC}+\text{PPE}+\text{OTHER\_FIXED\_ASSETS},$$

$$(9) \quad \text{NET\_ASSETS} \quad = \quad \text{DEBT}+\text{EQUITY}.$$

Here, NWC is defined as noncash current assets minus current operating liabilities; DEBT includes short-term debt, long-term debt, and other long-term liabilities; and EQUITY includes common and preferred stock. The market value of net assets is found by substituting the market value of common stock in place of the book value in equation (9). Our proxy for q is the market-to-book ratio of net assets.

Cash flow is typically measured as income before extraordinary items ("profits") plus depreciation, a measure that has at least four problems. First, and

[2]The 10th percentile is $327 million in 2009. Firms above this cutoff represent roughly half the firms on Compustat but more than 98% of aggregate asset value. We have repeated our tests using firms bigger than the NYSE 1st percentile, representing 99.6% of aggregate value, and found similar results. We have also repeated our tests dropping low-PPE firms in order to eliminate firms for which capital expenditures are not important. Again, results for that sample are very similar to those reported here. Details are available from the authors.

most obviously, it misses the cash flow effects of extraordinary items. Second, it incorrectly reflects accruals such as deferred taxes and asset write-downs that reduce profits but are not cash expenses (write-downs are typically classified as special, not extraordinary, items on Compustat). Third, profits include gains and losses from the sale of PPE, which are better classified as (negative) investments than as operating cash flows. Fourth, depreciation in the income statement is incomplete because it does not reflect depreciation that has been allocated to specific goods and included in the firm's cost of goods sold.

To overcome these problems, we measure cash flow, CF, using data from the statement of cash flows (SCF). Like the traditional measure, we start with income before extraordinary items plus depreciation (from the SCF) but then correct for the effects of extraordinary items, deferred taxes, the unremitted portion of earnings in unconsolidated subsidiaries, losses from the sale of PPE, and other funds from operations identified in the SCF.[3] Our procedure mimics the definition of operating cash flow in the SCF except that it excludes spending on working capital, which we view as a component of investment.

Figure 1 shows how CF evolves through time compared with income before extraordinary items plus depreciation (scaled by a firm's average net assets during the year). The two variables are highly cross-sectionally correlated during the first part of the sample but start to diverge significantly in the mid-1980s. Although both measures become more volatile over time, the relative volatility of PROF + DEPR increases rapidly in 1990 and spikes dramatically in 2000–2002 and 2008. The patterns suggest that PROF + DEPR becomes a noisier measure of cash flow during the second half of the sample, largely due to an increase in noncash special items. As we discuss further later in the paper, this fact helps to explain why recent studies tend to estimate low investment–cash flow sensitivities (see Section I).

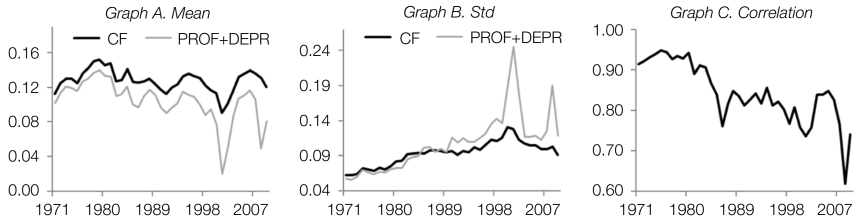
Our tests consider three measures of investment. Following the literature, the first measure, CAPX1, is simply capital expenditures (net). This variable misses a firm's spending on other fixed assets, such as patents bought from other firms or cash used for acquisitions. Our second measure, CAPX2, therefore includes these "investing activities" from the SCF. Finally, our broadest measure of long-term investment, CAPX3, is derived from the year-over-year change in fixed assets on the balance sheet, adjusted for noncash charges that affect fixed assets such as depreciation and write-downs (because our goal is to measure actual expenditures). An important point is that CAPX3 reflects all acquisitions, whereas the item "acquisitions" on Compustat picks up only cash expenditures. Therefore, stock-for-stock transactions are included in our broadest measure of investment but not in the first two measures. In essence, CAPX3 views any asset acquired by the firm as an investment, regardless of how the transaction is structured.

[3] The last item adjusts for asset write-downs. The precise definition is as follows: CF = IBC (income before extraordinary items) + XIDOC (extraordinary items and discontinued operations) + DPC (depreciation and amortization) + TXDC (deferred taxes) + ESUBC (equity in net loss of unconsolidated subsidiaries) + SPPIV (losses from the sale of PPE) + FOPO (funds from operations–other). All of these items come from the SCF.

FIGURE 1

Cross-Sectional Distribution of Cash Flow Measures

Figure 1 plots the annual cross-sectional mean, standard deviation, and correlation of cash flow (CF) and income before extraordinary items plus depreciation (PROF+DEPR). The variables are scaled by average net assets during the year and winsorized at their 1st and 99th percentiles. Data come from Compustat. The sample consists of all nonfinancial firms that are larger than the NYSE 10th percentile (measured by net assets at the beginning of the year).



One of our goals is to provide a complete picture of what firms do with cash flow. In addition to buying fixed assets, a firm can use cash flow to increase cash holdings, to invest in working capital, to pay down debt, to repurchase shares, and to pay dividends. The first three are measured as changes in cash holdings (ΔCASH), working capital (ΔNWC), and debt (ΔDEBT) during the year (DEBT includes long-term deferred taxes, so we adjust ΔDEBT to reflect accruals related to deferred taxes). Dividends (DIV) include cash dividends paid to common and preferred shareholders. Equity issuance (ISSUES) is measured as the change in total equity minus the change in retained earnings, capturing sales of both common and preferred stock. By virtue of the accounting identities in equations (8) and (9), the following relation holds approximately in the data:

$$(10) \quad \text{CF} \quad \approx \quad \Delta\text{CASH} + \Delta\text{NWC} + \text{CAPX3} - \Delta\text{DEBT} - \text{ISSUES} + \text{DIV}.$$

This relation is approximate only because so-called "dirty surplus" accounting means that some items affect equity directly without flowing through the income statement. An implication of equation (10) is that the slopes when the right-hand-side variables are regressed on CF should, appropriately signed, sum roughly to 1, a condition that holds closely in our tests.

We scale all level variables (cash, working capital, fixed assets, debt, and equity) by contemporaneous net assets and all flow variables by average net assets for the year (using the average helps to neutralize mechanical cash flow effects that could arise if investment becomes immediately profitable during the year). Finally, we winsorize the variables at their 1st and 99th percentiles to reduce the impact of outliers.

Table 1 reports descriptive statistics for our sample of roughly 1,800 firms per year from 1971–2009. The average firm has profits equal to 4.6% of net assets, depreciation of 6.1%, and other operating cash flow of 2.0%, implying that total cash flow equals 12.8% of net assets. CF is somewhat less variable than profits and, unlike profits, slightly positively skewed. Capital expenditures average 8.9% of net assets, growing to 11.6% of net assets when we include other investing activities from the SCF and to 14.1% of net assets based on our broadest measure of

TABLE 1
Descriptive Statistics (1971–2009)

Table 1 reports the time-series average of the annual cross-sectional mean, median, standard deviation (Std), 1st percentile (Min), 99th percentile (Max), and sample size (*N*) for the variables listed. All flow variables other than stock returns are scaled by average net assets during the year, whereas all level variables are scaled by ending net assets (net assets equal total assets minus nondebt current liabilities). Variables are winsorized annually at their 1st and 99th percentiles. Accounting data come from Compustat, and returns come from CRSP. The sample consists of all nonfinancial firms that are larger than the 10th percentile of NYSE firms (measured by net assets at the beginning of the year) and that have data for net assets and stock returns. OTHCF = operating cash flows other than income, depreciation, and working capital from the statement of cash flows (SCF); NWC = Noncash current assets − Nondebt current liabilities; FA = Total assets − Current assets; ISSUES = ΔTOTEQ − Change in retained earnings; CAPX2 = CAPX1 + Other investing activities from the SCF; CAPX3 = ΔFA + DEPR − Other noncash adjustments to FA from the SCF; CAPX4 = CAPX3 + ΔNWC.

Variable	Description	Mean	Median	Std	Min	Max	*N*
OP_PROF	Operating income	0.119	0.113	0.111	−0.231	0.457	1,816
PROF	Income before extraordinary items	0.046	0.055	0.105	−0.417	0.291	1,815
NI	Net income	0.044	0.055	0.112	−0.454	0.303	1,815
DEPR	Depreciation	0.061	0.053	0.036	0.007	0.218	1,776
OTHCF	Other operating cash flows	0.020	0.009	0.054	−0.112	0.310	1,776
CF	PROF + DEPR + OTHCF	0.128	0.123	0.094	−0.172	0.410	1,776
CASH	Cash holdings	0.119	0.062	0.144	0.001	0.693	1,809
NWC	Noncash net working capital	0.196	0.169	0.209	−0.246	0.752	1,791
PLANT	Property, plant, and equipment	0.476	0.431	0.262	0.033	1.003	1,814
FA	Fixed assets	0.686	0.704	0.236	0.143	1.081	1,799
DEBT1	Short-term debt + Long-term debt	0.357	0.344	0.232	0.000	1.162	1,817
DEBT2	Total nonoperating liabilities	0.466	0.462	0.253	0.011	1.342	1,811
TOTEQ	Shareholders' equity	0.534	0.538	0.253	−0.342	0.989	1,811
ΔNA	Change in net assets	0.081	0.068	0.203	−0.582	0.780	1,817
ΔCASH	Change in cash holdings	0.010	0.003	0.082	−0.256	0.338	1,806
ΔDEBT2	Change in DEBT2	0.037	0.015	0.148	−0.408	0.612	1,812
ΔTOTEQ	Change in TOTEQ	0.042	0.040	0.140	−0.497	0.511	1,812
INTEQ	Internal equity (NI − DIV)	0.024	0.036	0.108	−0.478	0.262	1,811
ISSUES	Share issuance	0.026	0.004	0.087	−0.174	0.455	1,799
CAPX1	Capital expenditures (net)	0.089	0.070	0.076	−0.027	0.410	1,801
CAPX2	CAPX1 + Other investments	0.116	0.091	0.121	−0.176	0.605	1,801
CAPX3	Total investment in fixed assets	0.141	0.109	0.158	−0.284	0.788	1,757
CAPX4	Total investment	0.152	0.127	0.188	−0.399	0.847	1,772
FCF1	CF − CAPX1	0.039	0.046	0.102	−0.336	0.311	1,764
FCF4	CF − CAPX4	−0.024	0.000	0.184	−0.727	0.483	1,772
SALES	Revenues	1.581	1.331	1.256	0.126	7.383	1,816
MB	Market-to-book asset ratio	1.617	1.282	1.011	0.637	6.558	1,800
DIV	Dividends	0.019	0.013	0.022	0.000	0.125	1,812
RETURN	Annual stock return	0.134	0.079	0.442	−0.690	1.869	1,817

long-term investment. Adding in working capital, firms invest 15.2% of net assets in an average year, 2.4% more than cash flow. Firms also use cash flow to increase cash holdings (1.0% of net assets) and to make dividend payments (1.9%), implying that the average firm has to raise more than 5% of net assets annually from new debt (3.7%) and equity (2.6%) issuance. The means and standard deviations of the variables provide only weak evidence that debt is a more important source of new funds than equity, consistent with Frank and Goyal (2003) and Fama and French (2005).

B. Unconstrained Firms

Ideally, we would like to isolate firms that are financially unconstrained in order to study how investment behaves in the absence of financing costs. These firms might be identified in two ways: The first would be to find firms that have sufficient internal funds to cover profitable investment opportunities; the second would be to identify firms that, even if they must raise external funds, can do so cheaply (i.e., for whom the parameter b in our model is small). The classification scheme we pursue is based more on the first idea than the second, although we suspect the two approaches overlap if the first dollars raised by a firm are nearly costless (e.g., because the firm has some pledgeable assets).[4]

To be specific, we sort firms at the beginning of each year based on their expected free cash flow for the year, defined for this purpose as cash flow in excess of capital expenditure (FCF1 in Table 1). We sort based on expected, rather than realized, free cash flow in part to avoid sorting on realized investment (the dependent variable in our tests) but also because expected cash flow might be more important than realized cash flow if investment decisions are planned in advance. We sort based on expected cash flow in excess of capital expenditures, rather than cash flow in excess of total investment (FCF4), because it is more predictable and seems, in some sense, more fundamental.

Expected free cash flow comes from a cross-sectional regression of FCF1 on lagged firm characteristics. Because we are not interested in individual slopes (multicollinearity is not relevant) and have a large cross section of firms, the forecasting regression includes all of the main variables in our data: CF, RETURN, investment (CAPX1, CAPX3, ΔNWC), DIV, DEBT, MB, SALES, PPE, DEPR, and the level of and change in CASH. Together, the variables predict a large fraction of the variation in subsequent FCF1, with an average R^2 of 46% in the annual regressions. We sort firms each year based on the fitted values from these regressions, classifying the top ⅓ firms as "unconstrained" and the bottom ⅓ as "constrained." Firms can move between groups each year as their expected free-cash-flow changes.[5]

Rather than report slopes from the predictive regressions, Table 2 shows how firms in the two groups evolve in the years before and after the sort (the sort takes place at the end of year 0 based on expected FCF1 in year +1). Leading up to the sort, unconstrained firms have high and increasing sales, profits, cash flow, dividends, cash holdings, and stock returns; they have relatively little debt and invest significantly less than constrained firms in all 3 years prior to the sort. By year 0, unconstrained firms have short-term assets (cash plus NWC) equal to 41.5% of net assets, compared with debt of 24.0% and total liabilities of 32.8%. Cash flow for unconstrained firms exceeds capital expenditures by 10.1%, 11.1%, and 13.2% of net assets in the 3 years leading up to the sort and exceeds total investment by an average of 2.1% of net assets. These patterns suggest that our

[4]To the extent our classification scheme works, we sidestep the concerns of Kaplan and Zingales (1997), who argue that investment–cash flow sensitivities do not have to be lower for moderately constrained versus highly constrained firms. (This point can be seen in equation (7) of our model, which shows that cash flow has the same impact on investment for any positive amount of external financing.) For our purposes, the more important prediction is that cash flow should not matter at all for unconstrained firms. Indeed, we do not try to rank firms based on how constrained they are or interpret investment–cash flow sensitivities as a measure of financing constraints. We simply try to identify a sample of "unconstrained" firms for which financing costs should not be important.

[5]The breakpoints change annually to keep ⅓ of the sample in each group, implying that the "constrainedness" of each group will vary depending on macroeconomic conditions (i.e., on how the typical firm is doing). As a robustness check, we have repeated our tests using the same absolute cutoff each year, classifying firms with E[FCF1] < 0% as "constrained" and firms with E[FCF1] > 8% as unconstrained (this produces groups that have just under 25% of the firms in a typical year). The results are similar to those reported later.

TABLE 2

Descriptive Statistics: Constrained versus Unconstrained Firms (1971–2009)

Table 2 compares the characteristics of constrained and unconstrained firms. The groups are defined at the end of year 0 based on expected free cash flow in year +1 (predicted in a cross-sectional regression of FCF1 on lagged firm characteristics); unconstrained firms represent the top ⅓ of firms ranked on this measure, and constrained firms represent the bottom ⅓. Flow variables are scaled by average net assets for the year, and level variables are scaled by ending net assets. The table reports the time-series average of the annual cross-sectional mean of each variable. The sample consists of all nonfinancial firms with data for net assets on Compustat and stock returns on CRSP, dropping firms smaller than the NYSE 10th percentile of net assets at the end of year 0. The variables are defined in Table 1.

	Panel A. Constrained					*Panel B. Unconstrained*				
Year	−2	−1	0	+1	+2	−2	−1	0	+1	+2
OP_PROF	0.090	0.080	0.058	0.055	0.062	0.199	0.203	0.212	0.198	0.185
PROF	0.031	0.023	0.000	−0.008	−0.003	0.105	0.109	0.119	0.108	0.097
NI	0.031	0.022	−0.002	−0.011	−0.004	0.105	0.109	0.119	0.108	0.096
DEPR	0.062	0.062	0.062	0.065	0.066	0.062	0.062	0.061	0.060	0.060
OTHCF	0.016	0.016	0.016	0.025	0.025	0.016	0.017	0.021	0.018	0.018
CF	0.109	0.100	0.078	0.082	0.089	0.184	0.189	0.202	0.187	0.177
CASH	0.123	0.120	0.112	0.109	0.112	0.154	0.157	0.161	0.158	0.152
NWC	0.135	0.129	0.125	0.119	0.116	0.266	0.260	0.254	0.249	0.249
PLANT	0.587	0.588	0.596	0.601	0.602	0.370	0.363	0.354	0.352	0.355
FA	0.742	0.750	0.762	0.771	0.773	0.578	0.582	0.584	0.592	0.599
DEBT1	0.401	0.410	0.436	0.444	0.442	0.259	0.255	0.240	0.246	0.253
DEBT2	0.504	0.514	0.545	0.565	0.570	0.341	0.339	0.328	0.336	0.347
TOTEQ	0.496	0.486	0.455	0.435	0.430	0.659	0.661	0.672	0.664	0.653
ΔNA	0.162	0.165	0.154	0.054	0.041	0.128	0.123	0.114	0.120	0.105
ΔCASH	0.025	0.022	0.013	−0.001	0.004	0.024	0.027	0.028	0.019	0.014
ΔDEBT2	0.068	0.078	0.098	0.041	0.026	0.032	0.028	0.014	0.041	0.043
ΔTOTEQ	0.084	0.078	0.050	0.010	0.013	0.091	0.091	0.095	0.076	0.061
INTEQ	0.016	0.009	−0.015	−0.023	−0.017	0.073	0.077	0.087	0.076	0.065
ISSUES	0.068	0.068	0.065	0.036	0.033	0.029	0.027	0.022	0.015	0.011
CAPX1	0.127	0.131	0.136	0.110	0.100	0.084	0.078	0.070	0.078	0.079
CAPX2	0.156	0.160	0.163	0.122	0.109	0.120	0.117	0.111	0.121	0.119
CAPX3	0.190	0.197	0.203	0.146	0.129	0.151	0.147	0.141	0.153	0.149
CAPX4	0.207	0.214	0.216	0.144	0.127	0.178	0.172	0.164	0.178	0.170
FCF1	−0.018	−0.032	−0.060	−0.029	−0.012	0.101	0.111	0.132	0.109	0.098
FCF4	−0.098	−0.113	−0.137	−0.063	−0.039	0.007	0.018	0.039	0.010	0.007
SALES	1.314	1.269	1.202	1.197	1.238	2.083	2.077	2.081	2.037	2.003
MB	1.615	1.565	1.402	1.358	1.372	2.277	2.302	2.291	2.177	2.092
DIV	0.014	0.013	0.012	0.011	0.012	0.029	0.030	0.030	0.030	0.030
RETURN	0.177	0.149	0.056	0.094	0.128	0.207	0.232	0.234	0.158	0.144

sort does a good job of identifying firms that are likely to be unconstrained, not just firms that have temporarily high cash flows, but firms with persistently high profitability, strong liquidity, and seemingly significant unused debt capacity.

IV. Basic Investment Regressions

We start with basic OLS regressions to provide the most direct view of how investment relates to cash flow and a baseline for our subsequent error-corrected estimates.

A. Methodology

Our main tests focus on average slopes from 39 annual cross-sectional regressions, from 1971–2009. We report standard errors based on the time-series variability of the slopes, incorporating a Newey–West (1987) correction with 3 lags to account for possible autocorrelation in the estimates. This approach has the advantage that it allows investment–cash flow sensitivities to vary over time and corrects very simply for both time-series and cross-sectional dependence in the data. It also allows the relation between MB and our instruments to vary over time in our later IV regressions.[6]

It is useful to note that we do not de-mean the variables relative to the firm's average or otherwise control for firm fixed effects (a common, but not universal, procedure in the literature). We are reluctant to do so both to avoid imposing survivorship requirements (it is only meaningful to adjust for firm fixed effects if a firm has multiple observations) and because adding fixed effects to the regressions can induce significant bias in the slopes. The latter problem arises because, in a fixed-effects regression, slopes are estimated from time-series variation within firms, and such estimates, with few observations per firm, can suffer from the biases discussed by Stambaugh (1999) and others. Despite these concerns, we have repeated all of our tests using de-meaned (within-firm) variables, restricting the sample to firms with at least 5 years of data, and found very similar cash flow effects to those reported. Any differences are noted in the text.

B. Results

Table 3 shows regressions for the full sample. The dependent variables include our three long-term investment measures, that is, capital expenditures (CAPX1), all investing activities from the SCF (CAPX2), and all purchases of fixed assets (CAPX3), along with changes in cash holdings (ΔCASH), investments in working capital (ΔNWC), changes in debt (ΔDEBT2), net share issuance (ISSUES), and dividends (DIV). Together, these provide a nearly complete picture of how firms spend cash flow.

Model 1 of Table 3 is the most basic investment model, with CF_t and MB_{t-1} as the only regressors (we use lagged MB following the convention in the literature). CF is strongly linked to both short-term and long-term investment in these regressions: A dollar of cash flow is associated with an extra \$0.14 of working capital ($t = 9.71$), \$0.26 of capital expenditure ($t = 9.06$), and \$0.35 of total long-term investment ($t = 9.11$). Thus, a dollar of cash flow leads to nearly \$0.50 of additional spending. The remainder is split fairly evenly between cash holdings (\$0.15), reductions in debt (\$0.13), lower share issuance (\$0.13), and higher dividends (\$0.06), effects that are all highly and statistically significant. Like our earlier descriptive statistics, the slopes for ΔDEBT2 and ISSUES provide little evidence that debt is the more important source of external funds.

For additional perspective, an increase in CF from 1 standard deviation below to 1 standard deviation above its mean predicts a jump in total investment from 10.7% to 19.8% of net assets (when MB equals its mean). CF and MB together explain about 13% of the variation in capital expenditures and 11% of the variation in total long-term investment.

[6]Petersen (2009) shows that autocorrelation-adjusted Fama–MacBeth (1973) standard errors may not fully capture serial correlation arising from firm fixed effects, although they seem to work reasonably well if firm effects are temporary and the number of cross sections is large. As a robustness check, we have repeated our tests using panel regressions with standard errors clustered by firm and year. The results are similar to those reported in the paper. In fact, standard errors in the panel regressions are often smaller than those reported here, probably because they do not reflect time variation in the true slopes that is captured by our Fama–MacBeth procedure.

Model 2 of Table 3 adds current and lagged stock returns to the regressions. Returns in the prior 2 years are strongly related to investment but have little impact on the estimated cash flow effects. The significance of returns is important because it provides a strong clue that MB measures q with error: If it did not, MB should subsume returns' explanatory power (returns could also be related to financing constraints, but that relation seems likely to be weaker than their correlation with investment opportunities).

TABLE 3
Investment and Cash Flow (1971–2009)

Table 3 reports average slopes, R^2s, and sample sizes (N) from annual cross-sectional regressions (intercepts are included in all regressions). t-statistics, reported below the slope estimates, are based on the time-series variability of the estimates, incorporating a Newey–West (1987) correction with 3 lags to account for possible autocorrelation in the estimates. Flow variables other than stock returns are scaled by average net assets during the year, whereas level variables are scaled by ending net assets. The variables are winsorized annually at their 1st and 99th percentiles. Accounting data come from Compustat, and returns come from CRSP. The sample consists of all nonfinancial firms larger than the NYSE 10th percentile (measured by net assets at the beginning of the year) and with data for all variables within each panel. Models 3 and 4 are estimated from 1972–2009. The variables are defined in Table 1.

	Dependent Variable							
	ΔCASH	ΔNWC	CAPX1	CAPX2	CAPX3	ΔDEBT2	ISSUES	DIV
Panel A. Model 1 (N = 1,683)								
CF_t	0.15	0.14	0.26	0.33	0.35	−0.13	−0.13	0.06
	9.24	9.71	9.06	16.22	9.11	−7.01	−3.58	6.69
MB_{t-1}	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.00
	2.81	2.99	2.33	4.20	5.91	6.49	7.16	3.43
R^2	0.051	0.045	0.129	0.122	0.109	0.019	0.052	0.144
Panel B. Model 2 (N = 1,605)								
CF_t	0.09	0.12	0.26	0.31	0.33	−0.17	−0.19	0.07
	6.41	10.45	10.66	16.25	9.48	−7.55	−4.96	6.99
MB_{t-1}	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.00
	6.15	1.32	0.76	2.58	4.14	4.66	8.36	4.50
$RETURN_t$	0.03	0.00	−0.01	0.00	0.00	0.01	0.03	0.00
	9.03	−0.09	−4.57	−0.29	0.36	0.94	6.41	−0.60
$RETURN_{t-1}$	0.00	0.02	0.02	0.03	0.04	0.04	0.02	0.00
	0.07	11.40	9.43	8.34	8.39	7.91	5.27	−3.04
$RETURN_{t-2}$	−0.01	0.02	0.02	0.03	0.04	0.04	0.01	0.00
	−5.08	7.62	9.60	13.18	11.97	12.25	3.37	−2.16
R^2	0.082	0.070	0.162	0.156	0.138	0.051	0.095	0.179
Panel C. Model 3 (N = 1,614)								
CF_t	0.11	0.11	0.15	0.14	0.12	−0.47	−0.15	0.04
	5.46	4.15	8.15	6.21	2.92	−15.56	−4.14	8.05
CF_{t-1}	−0.07	−0.01	0.24	0.32	0.38	0.38	−0.03	0.02
	−4.52	−0.56	5.29	7.44	11.73	11.48	−2.53	4.53
MB_{t-1}	0.01	0.00	0.00	0.00	0.00	0.01	0.02	0.00
	9.73	0.67	0.59	1.26	1.86	5.06	8.05	4.78
$CASH_{t-1}$	−0.11	0.01	−0.04	0.00	0.03	−0.08	0.00	−0.01
	−13.03	0.86	−3.47	0.24	1.91	−7.12	0.07	−4.56
$DEBT2_{t-1}$	−0.02	−0.03	0.05	0.03	0.03	−0.06	0.02	−0.02
	−10.21	−3.80	2.72	1.67	1.76	−4.61	3.67	−2.77
$RETURN_t$	0.03	0.00	−0.01	0.01	0.01	0.02	0.03	0.00
	8.04	0.07	−2.85	1.93	2.07	3.10	6.17	0.66
$RETURN_{t-1}$	0.00	0.03	0.01	0.03	0.04	0.04	0.02	0.00
	−0.36	11.75	6.18	6.64	6.80	8.35	4.87	−3.46
$RETURN_{t-2}$	0.00	0.02	0.01	0.02	0.03	0.03	0.01	0.00
	−4.20	9.30	7.19	7.69	7.77	9.69	3.39	−3.16
R^2	0.121	0.085	0.210	0.195	0.169	0.093	0.107	0.226

(continued on next page)

TABLE 3 (continued)
Investment and Cash Flow (1971–2009)

	Dependent Variable							
	ΔCASH	ΔNWC	CAPX1	CAPX2	CAPX3	ΔDEBT2	ISSUES	DIV
Panel D. Model 4 (N = 1,614)								
$U[CF_t]$	0.11	0.11	0.15	0.14	0.12	−0.47	−0.15	0.04
	5.46	4.15	8.15	6.21	2.92	−15.56	−4.14	8.05
$E[CF_t]$	0.01	0.09	0.50	0.61	0.68	0.09	−0.20	0.06
	0.61	4.05	6.31	9.30	10.04	3.07	−4.17	7.60
MB_{t-1}	0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.00
	10.34	0.84	−2.65	−2.33	−2.22	0.79	7.90	4.35
$CASH_{t-1}$	−0.11	0.00	−0.04	0.01	0.04	−0.07	0.00	−0.01
	−12.19	0.24	−2.57	0.50	1.89	−5.26	−0.24	−4.66
$DEBT2_{t-1}$	−0.03	−0.03	0.05	0.04	0.04	−0.05	0.02	−0.02
	−10.30	−3.91	2.84	1.92	2.07	−3.76	3.48	−2.72
$RETURN_t$	0.03	0.00	−0.01	0.01	0.01	0.02	0.03	0.00
	8.04	0.07	−2.85	1.93	2.07	3.10	6.17	0.66
$RETURN_{t-1}$	0.00	0.03	0.01	0.02	0.03	0.03	0.02	0.00
	0.65	11.38	2.81	4.47	4.87	6.41	5.00	−4.07
$RETURN_{t-2}$	−0.01	0.02	0.01	0.03	0.03	0.04	0.01	0.00
	−4.50	8.39	8.41	9.37	8.79	10.65	3.35	−2.89
R^2	0.121	0.085	0.210	0.195	0.169	0.093	0.107	0.226

Model 3 of Table 3 adds lagged cash flow to the regressions, along with beginning-of-year cash holdings and debt. Our main interest is in testing whether investment reacts with a delay to cash flow. We include cash and debt in the regressions, in part, because they are interesting in their own right and, in part, to test whether lagged cash flow is important only through its impact on the firm's financial position.

Lagged cash flow turns out to be strongly related to investment. Controlling for the other regressors, an extra dollar of prior-year cash flow is associated with \$0.24 of capital expenditures ($t = 5.29$) and \$0.38 of total fixed investment ($t = 11.73$). In addition, the slope on current cash flow drops significantly with lagged cash flow in the regression, from 0.26 to 0.15 for capital expenditures and from 0.35 to 0.12 for total fixed investment (the t-statistics drop to 8.15 and 2.92, respectively). Cash holdings and debt are not reliably significant across the various investment measures and have only a modest impact on the regressions.[7]

Prior-year cash flow could be important because investment decisions react with a delay either to changes in financing constraints or to the information about investment opportunities contained in cash flow. At first glance, the financing-constraints story seems hard to reconcile with the fact that CF_{t-1} is significant after

[7]We have also estimated specifications with lagged investment as a control variable. Cash flow effects in these regressions remain significant but are somewhat smaller than those in Table 3. For example, if we include lagged capital expenditures in model 3, the slope on CF_t drops to 0.11 ($t = 8.26$) for capital expenditures and to 0.08 ($t = 2.17$) for total fixed investment; the slope on CF_{t-1} drops to 0.04 ($t = 3.13$) for capital expenditures and to 0.21 ($t = 9.25$) for total fixed investment. We omit lagged investment from our main tests because it is endogenously chosen and inappropriate to use as a control variable. In particular, because higher cash flow leads to higher current investment, part of the impact of CF_{t-1} shows up in lagged investment. Taking that component out, by including lagged investment in the regressions, therefore understates the full impact of CF_{t-1} on current investment.

controlling for cash holdings, debt, and current cash flow, all of which are more direct measures of a firm's financial condition in year t. A more subtle argument is that CF_{t-1} affects *expected* cash flow in year t, and it might be this anticipated component that actually drives investment.

Unfortunately, it does not seem possible to distinguish empirically between a direct role for lagged cash flow and an indirect role through expectations; cash flow is highly persistent, so lagged and expected cash flow are highly correlated (we estimate an average R^2 of 58% when CF_t is regressed on its lag, rising only slightly to 61% when the other variables are added to the regression).

At a minimum, however, we can modify model 3 of Table 3 to facilitate an interpretation of the results in terms of expected and unexpected cash flows: We regress CF_t on the lagged variables in model 3 and use the residuals and fitted values from this first-stage regression in place of CF_t and CF_{t-1} in the model. The revised model is equivalent to model 3, with exactly the same R^2, but the new specification reinterprets the roles of CF_t and CF_{t-1} as unexpected and expected cash flows, respectively. In addition, the slopes on lagged MB, returns, cash holdings, and debt now show how those variables correlate with investment after controlling for their association with expected cash flow.

The results are reported as model 4 of Table 3. Unexpected cash flow, $U[CF_t]$, is only weakly related to investment, with a slope of 0.15 for capital expenditures ($t = 8.15$) and 0.12 for total fixed investment ($t = 2.92$). In contrast, expected cash flow, $E[CF_t]$, raises investment almost one-for-one: A dollar of expected cash flow is associated with an extra \$0.09 of working capital ($t = 4.15$), \$0.50 of capital expenditure ($t = 6.31$), and \$0.68 of spending on all fixed assets ($t = 10.04$), for a total investment–cash flow sensitivity of nearly 0.80. Moreover, expected cash flow and debt seem to be complements (a dollar of expected cash flow is associated with \$0.09 of new debt), in contrast to the strong substitution effect found for unexpected cash flow (−\$0.47). These results are consistent with q theory, to the extent that expected cash flow captures variation in q missed by MB, but are also consistent with expected cash flow having both a direct effect on financing frictions and an indirect effect through the relaxation of borrowing constraints.

It is also interesting that MB is now negatively related to investment (t-statistics of −2.22 to −2.65), although the slopes are insignificant if we drop past returns from the regression. Thus, the portion of MB that is orthogonal to expected cash flow has almost no connection to investment. The q-theory interpretation is that $E[CF_t]$ must dominate MB as a measure of q. The result is harder to reconcile with the mispricing view of Baker et al. (2003), who argue that MB is positively associated with investment in part because constrained firms prefer to cut back on investment when their stock is undervalued (low MB) rather than sell low-priced equity in the market. Our priors would be that the portion of MB that is orthogonal to expected cash flow should be a better proxy for mispricing than raw MB, but the opposite would have to be true to reconcile our results with their model.

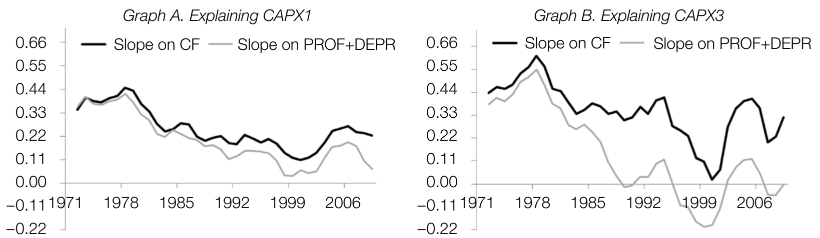
Figure 2 illustrates how investment–cash flow sensitivities change through time and compares the results to those using the conventional proxy for cash flow, income before extraordinary items plus depreciation (PROF + DEPR). Investment–cash flow sensitivities decline steadily for most of the sample but start to increase in 2000 and, using CF, end the sample only about one-third lower than in the early 1970s. If we split the sample in half (in 1990), the average slope on CF for capital expenditures drops from 0.32 in the first half to 0.19 in the second half; the slope on CF for total fixed investment drops from 0.43 to 0.27 (all four estimates have t-statistics greater than 6). The slope on PROF + DEPR is smaller and declines more substantially through time, from 0.30 to 0.11 for capital expenditures and from 0.31 to −0.02 for total fixed investment. The results are consistent with the fact that PROF + DEPR diverges significantly from cash flow after 1985 (see Figure 1).

The trend in the slope on PROF + DEPR mimics the findings of Chen and Chen (2012), who conclude that investment–cash flow sensitivities largely disappear in recent years. Our results suggest that a substantial part of the apparent decline can be attributed to the fact that PROF + DEPR has become an increasingly poor measure of cash flow over time.

FIGURE 2

Investment–Cash Flow Sensitivities (1971–2009)

Investment–cash flow sensitivities are estimated as the 2-year rolling average of the slopes on cash flow (CF) and income before extraordinary items plus depreciation (PROF + DEPR) when capital expenditures (CAPX1) and total fixed investment (CAPX3) are regressed on each variable and MB. The variables are scaled by average net assets during the year and winsorized at their 1st and 99th percentiles. The sample consists of all nonfinancial firms on Compustat that are larger than the NYSE 10th percentile (measured by net assets at the beginning of the year).



C. Constrained versus Unconstrained Firms

Table 4 divides the sample into constrained and unconstrained firms. The results show that cash flow effects are strong in both groups but tend to be significantly higher among constrained firms (i.e., those expected to need external financing).

Controlling just for MB, constrained firms spend an extra \$0.19 on working capital, \$0.41 on capital expenditures, and \$0.53 on all fixed assets for each additional dollar of cash flow, compared with cash flow effects of \$0.02, \$0.28, and \$0.29, respectively, for unconstrained firms. The differences are significant in all three cases, with t-statistics testing equality ranging from 4.50 to 6.12 (not tabulated). The total investment–cash flow sensitivity of constrained firms, 0.72, is more than double that of unconstrained firms, 0.30, and much greater than a narrow focus on capital expenditure would indicate. Unconstrained firms are much more inclined than constrained firms to reduce debt (0.30 vs. 0.01), and somewhat more inclined to raise dividends (0.07 vs. 0.02) and reduce share issuance

(0.14 vs. 0.07), in response to higher cash flow. Both groups increase their cash holdings by roughly \$0.15 for each additional dollar of cash flow.

Investment by constrained firms is also much more sensitive to MB, consistent with the findings of Baker et al. (2003). Constrained firms have a MB slope that is more than 10 times larger for capital expenditures (0.040 vs. 0.003) and 5 times larger for total fixed investment (0.061 vs. 0.011) compared with unconstrained firms, differences that are statistically significant (t-statistics of 5.00 and 8.33, respectively). q theory would tend to predict the opposite pattern, if MB is a good proxy for q, because unconstrained firms should react more aggressively to changes in investment opportunities (see Section II). Baker et al. attribute this result to the impact of mispricing on investment, which should be stronger for constrained firms that rely on new equity to finance growth.

The results are similar if returns are added to the regression (model 2 of Table 4): The slopes on CF and MB drop slightly in the investment regressions relative to model 1, but the comparison across groups does not change. And past returns, like MB, are more strongly related to investment for constrained than unconstrained firms (the table reports the sum of the slopes on past returns to save space).

Model 3 of Table 4 includes lagged cash flow, cash holdings, and debt in the regressions. Lagged cash flow is highly significant and, unlike current cash flow, has about the same impact on investment for the two groups: An additional dollar of prior-year cash flow is associated with \$0.42 of capital expenditures and \$0.47 of total fixed investment for constrained firms, compared with estimates of \$0.27 and \$0.53, respectively, for unconstrained firms (t-statistics of 11.56–15.56). The difference between the groups is significant for capital expenditures ($t = 8.09$) but not for total fixed investment ($t = -1.03$).

Model 4 of Table 4 reinterprets the role of lagged cash flow via its impact on expected cash flow. As we did for the full sample, we replace CF_{t-1} and CF_t with expected and unexpected cash flow, respectively (estimated in separate first-stage regressions for constrained and unconstrained firms). Fixed investment increases almost one-for-one with expected cash flow for both constrained (\$0.91) and unconstrained (\$0.84) firms, the majority of which represents increases in capital expenditures. Unexpected cash flow has a smaller impact on investment but helps to drive the different investment–cash flow sensitivities of the two groups: Constrained firms invest an extra \$0.19 in working capital ($t = 8.71$) and \$0.20 in fixed assets ($t = 7.76$) for each dollar of unexpected cash flow, compared with insignificant effects of −\$0.02 and \$0.00, respectively, for unconstrained firms.

Perhaps the most surprising result from model 4 of Table 4 is that after controlling for expected cash flow, investment is negatively related to MB for unconstrained firms. That finding is hard to reconcile either with q theory (measurement error might explain an insignificant slope, but not a negative one) or with Baker et al.'s (2003) mispricing story. One intriguing possibility is that free-cash-flow problems might be so severe among unconstrained firms that higher investment actually reduces firm value.

Overall, Tables 3 and 4 provide strong evidence that cash flow is significantly related to investment after controlling for MB and stock returns. The effects are economically large, implying that spending increases by \$0.51 for unconstrained

TABLE 4

Cash Flow and Investment for Constrained versus Unconstrained Firms (1972–2009)

Table 4 reports average slopes, R^2s, and sample sizes (N) from annual cross-sectional regressions for constrained (Cons.) and unconstrained (Unc.) firms (intercepts are included in all regressions). t-statistics, reported below the slope estimates, are based on the time-series variability of the estimates, incorporating a Newey–West (1987) correction with 3 lags to account for possible autocorrelation in the estimates. The groups are determined at the beginning of the year based on expected free cash flow for the year. Variables are winsorized annually at the 1st and 99th percentiles. Accounting data come from Compustat, and returns come from CRSP. The sample consists of all nonfinancial firms larger than the NYSE 10th percentile, measured by net assets at the beginning of the year. The variables are defined in Table 1.

	ΔCASH		ΔNWC		CAPX1		CAPX2		CAPX3		ΔDEBT2		ISSUES		DIV	
	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.
Panel A. Model 1 (N = 548 for constrained, N = 549 for unconstrained)																
CF_t	0.16	0.13	0.19	0.02	0.41	0.28	0.51	0.26	0.53	0.29	−0.01	−0.30	−0.07	−0.14	0.02	0.07
	5.55	7.88	8.34	0.93	10.66	9.91	15.75	7.07	12.33	5.81	−0.43	−11.82	−2.72	−3.24	4.52	6.45
MB_{t-1}	0.00	0.01	0.01	0.01	0.04	0.00	0.05	0.01	0.06	0.01	0.04	0.02	0.03	0.01	0.00	0.00
	0.59	2.94	4.81	2.69	5.21	1.95	6.99	4.98	11.43	5.17	7.40	8.05	12.35	5.82	−1.85	3.16
R^2	0.051	0.052	0.071	0.021	0.271	0.188	0.242	0.084	0.191	0.082	0.038	0.031	0.090	0.050	0.043	0.127
Panel B. Model 2 (N = 522 for constrained, N = 532 for unconstrained)																
CF_t	0.12	0.07	0.17	0.00	0.39	0.29	0.47	0.24	0.48	0.27	−0.08	−0.33	−0.12	−0.21	0.02	0.08
	4.63	3.23	9.92	−0.02	11.00	10.07	15.70	6.13	13.02	4.96	−2.55	−10.88	−4.48	−4.51	3.92	6.48
MB_{t-1}	0.01	0.01	0.00	0.00	0.03	0.00	0.04	0.01	0.04	0.01	0.02	0.02	0.03	0.01	0.00	0.01
	2.49	5.47	2.50	1.73	4.45	0.32	5.37	2.93	7.50	3.13	3.98	6.63	12.51	7.35	−2.79	4.38
$RETURN_t$	0.03	0.04	0.00	0.00	−0.01	−0.01	0.00	0.01	0.00	0.01	0.01	0.02	0.03	0.04	0.00	0.00
	8.75	6.98	0.49	−0.16	−2.50	−5.60	−0.52	1.58	0.32	1.38	1.01	2.00	7.93	5.31	0.74	−1.95
$RETURN_{t-2,t-1}$	−0.01	0.00	0.03	0.05	0.05	0.02	0.07	0.04	0.09	0.05	0.10	0.04	0.02	0.04	0.01	−0.02
	−4.21	0.92	5.64	14.02	20.14	5.07	11.55	7.71	10.65	7.40	12.09	5.75	3.55	5.15	3.05	−8.64
R^2	0.088	0.090	0.092	0.050	0.310	0.212	0.284	0.109	0.223	0.106	0.083	0.052	0.129	0.106	0.095	0.194
Panel C. Model 3 (N = 522 for constrained, N = 532 for unconstrained)																
CF_t	0.11	0.12	0.19	−0.02	0.12	0.15	0.20	0.04	0.20	0.00	−0.39	−0.57	−0.10	−0.24	0.01	0.07
	5.68	3.43	8.71	−0.59	6.55	7.67	10.34	0.87	7.76	−0.05	−9.84	−16.56	−3.87	−4.41	4.08	8.70
CF_{t-1}	−0.08	−0.08	−0.02	0.00	0.42	0.27	0.45	0.40	0.47	0.53	0.42	0.41	−0.03	0.07	0.00	0.00
	−8.04	−3.72	−0.71	0.03	15.56	12.52	13.57	13.03	13.58	11.16	9.67	20.30	−2.15	3.25	−0.28	−0.45
MB_{t-1}	0.02	0.01	0.00	0.00	0.03	0.00	0.03	0.00	0.04	0.00	0.02	0.01	0.03	0.01	0.00	0.01
	4.99	9.75	0.14	1.94	6.07	−1.21	6.08	0.37	7.82	0.06	5.76	6.24	11.48	6.55	−2.30	5.40

(continued on next page)

TABLE 4 (continued)

Cash Flow and Investment for Constrained versus Unconstrained Firms (1972–2009)

	ΔCASH		ΔNWC		CAPX1		CAPX2		CAPX3		ΔDEBT2		ISSUES		DIV	
	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.
Panel C. Model 3 (N = 522 for constrained, N = 532 for unconstrained) (continued)																
$CASH_{t-1}$	−0.18	−0.05	0.03	−0.02	0.01	−0.05	0.08	−0.02	0.09	0.00	−0.06	−0.08	−0.02	0.01	−0.03	−0.01
	−12.54	−4.32	2.42	−3.34	1.74	−14.19	5.36	−2.00	5.95	0.36	−3.17	−6.16	−1.54	1.39	−3.44	−4.09
$DEBT2_{t-1}$	−0.02	−0.02	−0.01	−0.04	0.01	0.00	0.00	0.00	−0.01	0.02	−0.06	−0.08	0.00	0.02	−0.01	−0.02
	−5.68	−5.19	−1.52	−5.83	1.05	0.48	0.33	−0.09	−1.28	1.39	−4.69	−7.37	−0.02	2.66	−2.55	−2.32
$RETURN_t$	0.03	0.04	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.02	0.02	0.03	0.03	0.04	0.00	0.00
	7.42	6.67	−0.09	0.35	1.19	−2.12	1.81	3.44	2.19	2.82	3.31	3.41	7.94	5.31	1.34	−1.48
$RETURN_{t-2,t-1}$	−0.01	0.01	0.03	0.05	0.03	0.01	0.05	0.04	0.07	0.05	0.08	0.04	0.02	0.04	0.01	−0.02
	−3.24	1.05	6.35	14.88	10.85	3.33	7.98	5.37	7.78	5.10	11.34	5.34	3.63	4.86	3.57	−8.20
R^2	0.175	0.116	0.113	0.070	0.386	0.278	0.337	0.154	0.266	0.151	0.135	0.102	0.142	0.121	0.147	0.252
Panel D. Model 4 (N = 522 for constrained, N = 532 for unconstrained)																
$U[CF_t]$	0.11	0.12	0.19	−0.02	0.12	0.15	0.20	0.04	0.20	0.00	−0.39	−0.57	−0.10	−0.24	0.01	0.07
	5.68	3.43	8.71	−0.59	6.55	7.67	10.34	0.87	7.76	−0.05	−9.84	−16.56	−3.87	−4.41	4.08	8.70
$E[CF_t]$	−0.02	−0.02	0.17	−0.01	0.75	0.61	0.87	0.68	0.91	0.84	0.23	0.11	−0.15	−0.14	0.01	0.06
	−1.17	−1.61	5.38	−0.19	13.75	12.08	19.04	11.82	18.75	17.29	4.95	4.40	−3.91	−3.38	1.40	3.74
MB_{t-1}	0.02	0.01	0.00	0.00	0.02	−0.01	0.02	−0.01	0.03	−0.01	0.01	0.00	0.03	0.01	0.00	0.01
	5.65	11.45	0.26	1.53	5.67	−6.36	5.66	−5.05	6.85	−4.91	3.95	−0.69	11.65	4.97	−2.19	4.95
$CASH_{t-1}$	−0.18	−0.05	0.03	−0.02	0.02	−0.04	0.08	−0.01	0.10	0.02	−0.06	−0.07	−0.02	0.01	−0.03	−0.01
	−11.79	−4.38	1.74	−3.02	1.53	−9.99	4.22	−0.93	4.68	2.12	−2.70	−5.45	−1.71	1.44	−3.47	−4.21
$DEBT2_{t-1}$	−0.02	−0.03	−0.01	−0.04	0.02	0.01	0.01	0.01	0.00	0.03	−0.05	−0.07	0.00	0.02	−0.01	−0.02
	−6.51	−6.22	−1.48	−5.95	2.38	1.23	1.53	0.56	−0.29	1.83	−3.93	−7.17	0.06	2.66	−2.57	−2.35
$RETURN_t$	0.03	0.04	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.02	0.02	0.03	0.03	0.04	0.00	0.00
	7.42	6.67	−0.09	0.35	1.19	−2.12	1.81	3.44	2.19	2.82	3.31	3.41	7.94	5.31	1.34	−1.48
$RETURN_{t-2,t-1}$	−0.01	0.01	0.03	0.05	0.02	0.01	0.04	0.04	0.06	0.04	0.08	0.03	0.02	0.03	0.01	−0.02
	−2.74	1.13	6.34	16.18	6.45	2.41	6.07	4.57	6.17	4.27	9.62	4.45	3.82	4.92	3.58	−8.61
R^2	0.175	0.116	0.113	0.070	0.386	0.278	0.337	0.154	0.266	0.151	0.135	0.102	0.142	0.121	0.147	0.252

firms and \$0.84 for constrained firms when current- and prior-year cash flows increase by \$1.00 (model 3 in the tables).

V. Measurement Error in q

In principle, investment opportunities could explain many of the cash flow effects previously described if MB is a noisy proxy for q. Measurement error in q might also contaminate the comparison between constrained and unconstrained firms. In this section, we test whether measurement error does explain the results and provide error-corrected estimates of the slopes.

A. Methodology

Our goal here is to estimate an empirical version of equation (7), that is,

$$\text{INV} = c_0 + c_1 q + c_2 \text{CF} + \varepsilon, \tag{11}$$

recognizing that MB is an imperfect proxy for q:

$$\text{MB} = g_0 + g_1 q + \eta. \tag{12}$$

We use a version of the standard IV approach in the literature, the main innovation being in our choice of instruments. Prior studies typically use lagged MB or changes in MB as instruments. However, as noted by Almeida et al. (2010) and EW (2012), that approach depends on the strong assumption that current and lagged measurement errors are uncorrelated. As an alternative, we use lagged *returns* as an instrument for q, based on the logic that measurement error in MB is more likely to come from book value in the denominator than from market value in the numerator. Even if market prices measure true value with error, it still seems reasonable to assume that stock prices are driven primarily by fundamental value (see, e.g., Cohen, Polk, and Vuolteenaho (2009)).

To be specific, we start with a first-stage regression of MB on cash flow and past returns. The fitted value from this regression then replaces q in equation (11), yielding a consistent estimate of c_2 under the assumption that returns and cash flow are correlated with q but not with η. More generally, let x be any set of variables that is orthogonal to η. The slopes in the first-stage regression, $\text{MB} = \delta_0 + \delta_1' x + \omega$, are proportional to those when q is regressed on x, with constant of proportionality g_1 from equation (12). In addition,

$$\text{INV} = c_0 + c_1^*(\delta_1' x) + c_2 \text{CF} + \varepsilon^*, \tag{13}$$

where $c_1^* = c_1/g_1$ and $\varepsilon^* = \varepsilon + c_1 \mu$. As long as CF is included in x, ε^* is uncorrelated with both regressors, and equation (13) provides a consistent estimate of c_2. The idea is simply that the fitted value from the first-stage regression, $\delta_1' x$, captures how CF relates to q, so the slope on CF in the second-stage regression in equation (13) reflects just the portion of CF that is unrelated to investment opportunities.

We recognize that our IV estimator may not be perfect. The biggest concern, in our view, is that error in the book value of assets could induce a positive correlation between scaled CF and η, leading to a *downward* bias in the slope on cash flow.[8] This turns out not to be a big problem for our conclusions because cash flow effects remain significant anyway. In a sense, our results may well be conservative in that they might attribute too much of the cash flow effects to investment opportunities and too little to financing frictions (whereas OLS regressions likely do the opposite).

Using past returns as an instrument for q could also be problematic. EW (2012) suggest that returns might be correlated with measurement error in MB, although, again, we use returns rather than lagged MB specifically because returns do not depend on the book value of assets and seem less likely to be correlated with η. A separate concern is that returns might enter the investment regression directly, not just through their correlation with current q. For example, lagged returns might be correlated with lagged q, and if investment takes time, both current and lagged q might explain investment (equation (11) implicitly ruled this out by including only current q as an explanatory variable).

The Appendix reports several robustness checks to address these concerns: i) We drop returns from the first-stage regressions and instead use either lagged cash flow or current squared cash flow as instruments for q (the latter is discussed in the next paragraph). ii) We continue to use returns but add MB_{t-2} to the investment regressions to address the possibility that lagged q might enter the regression (we instrument for both MB_{t-1} and MB_{t-2}). iii) We drop recent returns from the set of instruments, the logic being that more distant returns are less likely to correlate with measurement error in MB. The upshot is that the results reported in the text seem to provide, if anything, conservative estimates of cash flow effects.

An alternative to IV regressions would be to use the higher-order moment estimators of EW (2000), (2012). Given the popularity of that approach, it may be useful note that two of our IV-based estimators in the Appendix are valid under EW's assumptions but simply obtain identification differently. As a quick review, EW (2000), (2012) start with same basic model that we consider:

$$\text{INV} = c_0 + c_1 q + c_2 \text{CF} + \varepsilon, \tag{14}$$

$$\text{MB} = g_0 + g_1 q + \eta. \tag{15}$$

Rather than instrument for q, they derive a higher-moment estimator based on the generalized method of moments (GMM) under the assumption that η and ε are statistically independent of each other and of CF and q (identification requires that the appropriate higher moments are nonzero).[9] However, the same assumptions

[8] Suppose that CF is positively correlated with η, contrary to the assumptions of our IV estimator. We can write $\eta = \lambda' x + \eta^* = \lambda_{\text{CF}}\text{CF} + \eta^*$, where $\lambda_{\text{CF}} > 0$ and η^* is orthogonal to x. In the regression of MB on x, the slope becomes $\gamma_2 = g_1\gamma_1 + \lambda$ and, from equation (11), $\text{INV} = c_0 + c_1^*(\gamma_2' x) + (c_2 - c_1^*\lambda_{\text{CF}})\text{CF} + \varepsilon^*$. Thus, if $\lambda_{\text{CF}} > 0$, the error-corrected slope on CF will be biased downward, assuming that q is positively correlated with investment ($c_1^* > 0$).

[9] The simplest version of the estimator exploits information in third moments and can be implemented in three steps. The first step is to get the residuals, ε_{INV} and ε_{MB}, when INV and MB are regressed on CF and a constant. The second step is to estimate the moments $\text{E}[\varepsilon_{\text{INV}}^2 \varepsilon_{\text{MB}}]$ and $\text{E}[\varepsilon_{\text{INV}} \varepsilon_{\text{MB}}^2]$, the ratio of which, under the previous independence assumption, provides a consistent estimator of c_1 (for identification, the moment used in the denominator, $\text{E}[\varepsilon_{\text{INV}} \varepsilon_{\text{MB}}^2]$, cannot be 0). Third, given c_1, the slope on CF is obtained using basic regression identities that relate the slopes in the multiple regression in equation (14) to the slopes in the simple regressions estimated in step 1.

imply that squared CF is a valid instrument for q, where identification requires that squared CF correlates with q. Lagged CF is also a valid instrument for q if independence holds on a lead–lag basis (i.e., if η is uncorrelated with both current and prior CF). Thus, our IV estimators in the Appendix provide a simple way to exploit EW's independence assumption without requiring some of their auxiliary assumptions. Again, we use returns as an instrument in the main text because it provides the most conservative estimates.

B. Results

Table 5 reports the first-stage regressions of MB on cash flow and returns. CF_t by itself explains 23% of the variation in MB for the full sample of firms, with a slope of 5.18 ($t=10.24$). The relation is much weaker for constrained than for unconstrained firms (slopes of 1.01 and 8.58, respectively). The small coefficient for constrained firms poses a challenge for q theory, as we will see formally in a moment, because cash flow for that group is at once strongly related to investment but weakly related to q.

TABLE 5

Explaining q (1971–2009)

Table 5 reports average slopes, R^2s, and sample sizes from annual cross-sectional regressions of firms' MB ratios at the end of year $t-1$ on cash flow (CF) and returns (RETURN). t-statistics, reported below the slopes, are based on the time-series variability of the estimates, incorporating a Newey–West (1987) correction with 3 lags. The full sample (All) includes all nonfinancial firms larger than the NYSE 10th percentile of net assets. The constrained (Cons.) and unconstrained (Unc.) subsamples are determined at the beginning of the year based on the firm's predicted cash flows in excess of capital expenditures (unconstrained firms represent the top ⅓ of firms ranked on this measure; constrained firms represent the bottom ⅓). Variables are winsorized annually at their 1st and 99th percentiles.

	Model 1			Model 2			Model 3			Model 4		
	All	Cons.	Unc.	All	Cons.	Unc.	All	Cons.	Unc.	All	Cons.	Unc.
CF_t	5.18	1.01	8.58	2.33	0.84	4.39	2.09	0.60	3.84	2.31	0.81	3.91
	10.24	2.20	10.04	8.66	5.54	10.35	8.89	6.59	9.53	9.41	7.55	9.46
CF_{t-1}				3.75	0.18	6.72	3.26	−0.43	6.12	2.74	−0.99	5.15
				9.41	0.24	6.63	10.34	−0.77	7.59	13.40	−1.99	8.71
$RETURN_{t-1}$							0.46	0.51	0.55	0.48	0.49	0.58
							4.56	6.68	3.76	4.77	6.75	4.12
$RETURN_{t-2}$							0.32	0.37	0.36	0.34	0.37	0.39
							3.99	6.15	2.98	4.27	7.39	3.10
$RETURN_{t-3}$										0.31	0.26	0.43
										4.18	7.28	3.70
$RETURN_{t-4}$										0.28	0.21	0.40
										4.49	5.35	4.39
R^2	0.231	0.063	0.298	0.281	0.103	0.377	0.361	0.259	0.447	0.407	0.313	0.495
N	1,723	552	552	1,721	552	552	1,647	525	535	1,493	456	495

The remaining columns in Table 5 add lagged cash flow and returns to the regression. Current- and prior-year CF are strongly related to MB, with individual slopes that roughly split the slope on cash flow in model 1. Returns up to 4 years in the past also have significant explanatory power, with slopes that decay from 0.50–0.60 at lag 1 to 0.21–0.40 at lag 4 (the t-statistics range from 3.10 to 7.39). For our purposes, a key finding is that returns raise the R^2s substantially, implying that they explain significant variation in MB that is orthogonal to cash flow. Thus, the fitted value from the regressions (our instrument for q) has sufficiently low correlation with cash flows to permit precise estimates of the investment equation. The trade-off we face by adding more return lags is that we explain more variation in MB but reduce the number of firms with data. For our subsequent tests, we include all 4 return lags in the first-stage regression in the belief that the gain in R^2 more than compensates for the modest drop in sample size.[10]

Table 6 reports error-corrected estimates of the investment equation for the full sample of firms. Model 1, with CF_t and instrumented MB_{t-1} in the regression, is the direct analog of model 1 in Table 3. After correcting for measurement

TABLE 6

Investment and Cash Flow: Correcting for Measurement Error in *q* (1972–2009)

Table 6 reports average slopes, R^2s, and sample sizes (N) from annual cross-sectional regressions. MB* is the fitted value when MB is regressed on current and lagged cash flow (CF_t and CF_{t-1}), 4 lags of stock returns, and, for model 3, lagged cash holdings ($CASH_{t-1}$) and debt ($DEBT2_{t-1}$). *t*-statistics, reported below the slope estimates, are based on the time-series variability of the estimates, incorporating a Newey–West (1987) correction with 3 lags to account for possible autocorrelation in the estimates. Flow variables are scaled by average net assets during the year, whereas level variables are scaled by ending net assets. Variables are winsorized annually at their 1st and 99th percentiles. Accounting data come from Compustat, and returns come from CRSP. The sample consists of all nonfinancial firms larger than the 10th percentile of NYSE firms, as measured by net assets at the beginning of the year, and with data available for all variables within each panel.

	Dependent Variable							
	ΔCASH	ΔNWC	CAPX1	CAPX2	CAPX3	ΔDEBT2	ISSUES	DIV
Panel A. Model 1 (N = 1,465)								
CF_t	0.18	0.04	0.08	0.04	0.00	−0.49	−0.19	0.08
	10.37	2.47	3.46	0.77	−0.06	−10.82	−3.56	8.59
MB^*_{t-1}	−0.01	0.03	0.05	0.08	0.09	0.10	0.02	0.00
	−1.76	4.32	5.51	8.04	9.59	7.05	5.26	0.49
R^2	0.048	0.057	0.174	0.170	0.147	0.058	0.052	0.169
Panel B. Model 2 (N = 1,465)								
CF_t	0.19	0.06	0.06	0.03	−0.02	−0.53	−0.15	0.07
	11.39	2.05	2.83	0.54	−0.36	−14.05	−2.92	8.33
CF_{t-1}	−0.11	−0.04	0.10	0.13	0.14	0.27	−0.16	0.07
	−5.46	−0.80	3.82	3.59	4.19	5.76	−5.31	6.75
MB^*_{t-1}	0.01	0.03	0.03	0.06	0.07	0.06	0.04	−0.01
	2.12	3.44	4.80	5.89	6.61	4.48	5.39	−2.05
R^2	0.054	0.065	0.181	0.175	0.151	0.069	0.064	0.191
Panel C. Model 3 (N = 1,465)								
CF_t	0.19	0.04	0.07	0.01	−0.03	−0.57	−0.15	0.06
	10.37	1.28	2.09	0.18	−0.40	−15.30	−2.86	9.10
CF_{t-1}	−0.11	−0.08	0.16	0.15	0.16	0.21	−0.14	0.05
	−7.59	−1.64	2.87	2.05	2.35	3.35	−3.82	7.78
$CASH_{t-1}$	−0.09	−0.05	−0.11	−0.13	−0.14	−0.20	−0.06	0.00
	−11.82	−4.32	−6.95	−3.63	−3.72	−7.95	−3.21	0.72
$DEBT2_{t-1}$	−0.02	−0.02	0.04	0.03	0.03	−0.05	0.02	−0.02
	−8.64	−3.94	2.38	1.27	1.37	−3.82	3.12	−2.46
MB^*_{t-1}	0.01	0.04	0.03	0.06	0.08	0.08	0.04	−0.01
	2.62	4.22	5.93	5.31	5.92	5.15	5.34	−2.04
R^2	0.085	0.076	0.215	0.198	0.169	0.085	0.074	0.237

[10]We find similar results if we instead use 3 or 5 return lags in the first-stage regression. Cash flow effects in the investment regressions tend to be slightly stronger when more lags are included, consistent with the fact that the first-stage regressions then pick up more variation in MB that is orthogonal to cash flow.

error, an extra dollar of cash flow is associated with \$0.08 of capital expenditure ($t = 3.46$) and \$0.00 of total fixed investment ($t = -0.16$), compared with estimates of \$0.26 and \$0.35 in Table 3. Summing working capital and fixed assets, the total investment–cash flow sensitivity drops from 0.49 in Table 3 to just 0.04 here. Thus, a significant portion of the cash flow effects estimated earlier can be attributed to a correlation between cash flow and q.[11] After controlling for q, cash flow is used mostly to reduce debt (\$0.49), with the remainder split fairly evenly between additions to cash holdings (\$0.18), lower share issuance (\$0.19), and increases in dividends (\$0.08).

Model 2 of Table 6 adds lagged cash flow to the regression. The slopes on lagged cash flow drop substantially relative to our earlier estimates but, unlike those on current CF, remain significant for all three long-term investment measures. Controlling for q and current cash flow, an extra dollar of prior-year cash flow is associated with \$0.10 of capital expenditures ($t = 3.82$) and \$0.14 of total fixed investment ($t = 4.19$), down from estimates of \$0.24 and \$0.38, respectively, in Table 3. These results suggest that much of the combined effect of current and lagged cash flow relates to investment opportunities, but cash flow also seems to have a direct impact on investment, consistent with a role for financing frictions.

For completeness, model 3 of Table 6 adds cash holdings and debt to the regression, as we did in Table 3 (they are also included in the first-stage regression to control for their correlation with q). The variables are significantly related to investment but have signs that are opposite to naive expectations, positive for debt and negative for cash holdings. (Those effects are presumably driven by the endogenous choice of cash and debt levels, decisions that are beyond the scope of our paper.) For our purposes, the key result is that adding CASH_{t-1} and DEBT2_{t-1} to the regression has only a small impact on the cash flow effects, slightly raising the slopes overall. For example, the slope on CF_{t-1} increases to 0.16 for both capital expenditures and total fixed investment (t-statistics of 2.87 and 2.35, respectively).

Table 7 repeats the analysis for constrained and unconstrained firms. Measurement error in MB does not fully explain the cash flow effects for either group, but the corrections have a uniformly larger impact on the slopes for unconstrained firms, increasing the wedge between the two groups and, hence, the apparent impact of financing constraints. In model 1 of Table 7, with just CF and MB^*_{t-1} in the regression, constrained firms invest an extra \$0.35 in capital expenditures ($t = 13.23$) and \$0.45 in all fixed assets ($t = 15.25$) for each additional dollar of cash flow, down only slightly from the estimates in Table 4. In comparison, unconstrained firms invest an extra \$0.14 in capital expenditures ($t = 5.08$) and $-$\$0.05 in all fixed assets ($t = -0.46$), substantially lower than the estimates of \$0.28

[11]This is one instance where adjusting for firm fixed effects makes a difference (see our discussion in Section IV.A). In particular, the error-corrected slope on CF_t remains significant for all investment measures if we use de-meaned (within-firm) data in the tests. Comparing OLS and IV estimates, the slope drops from 0.22 to 0.14 for working capital, from 0.20 to 0.08 for capital expenditures, and from 0.33 to 0.09 for total fixed investment (t-statistics for the estimates drop from 11.17, 8.83, and 11.55 to 5.19, 4.32, and 2.74, respectively).

TABLE 7

Cash Flow and Investment for Constrained versus Unconstrained Firms: Correcting for Measurement Error in q (1972–2009)

Table 7 reports average slopes, R^2s, and sample sizes (N) from annual cross-sectional regressions for constrained (Cons.) and unconstrained (Unc.) firms. MB* is the fitted value when MB is regressed on current and lagged cash flow (CF_t and CF_{t-1}), 4 lags of stock returns, and, for model 3, lagged cash holdings ($CASH_{t-1}$) and debt ($DEBT2_{t-1}$). t-statistics, reported below the slope estimates, are based on the time-series variability of the estimates, incorporating a Newey–West (1987) correction with 3 lags to account for possible autocorrelation in the estimates. Flow variables are scaled by average net assets during the year, whereas level variables are scaled by ending net assets. Variables are winsorized annually at their 1st and 99th percentiles. Accounting data come from Compustat, and returns come from CRSP. The sample consists of all nonfinancial firms larger than the 10th percentile of NYSE firms, as measured by net assets at the beginning of the year, and with data available for all variables within each panel. The variables are defined in Table 1.

	ΔCASH		ΔNWC		CAPX1		CAPX2		CAPX3		ΔDEBT2		ISSUES		DIV	
	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.
Panel A. Model 1 ($N=454$ for constrained, $N=493$ for unconstrained)																
CF_t	0.16	0.15	0.16	−0.06	0.35	0.14	0.43	0.01	0.45	−0.05	−0.15	−0.54	−0.07	−0.23	0.02	0.12
	7.40	5.13	7.35	−1.69	13.23	5.08	14.42	0.10	15.25	−0.46	−2.56	−10.44	−3.23	−3.82	2.84	10.22
MB^*_{t-1}	−0.01	0.00	0.04	0.02	0.09	0.02	0.12	0.04	0.15	0.05	0.15	0.05	0.04	0.02	0.00	0.00
	−1.84	−0.06	4.71	2.70	4.01	5.52	5.32	6.58	6.21	6.90	4.49	6.65	6.53	6.17	0.84	−0.60
R^2	0.050	0.056	0.086	0.032	0.308	0.222	0.281	0.114	0.220	0.113	0.075	0.052	0.097	0.057	0.063	0.189
Panel B. Model 2 ($N=454$ for constrained, $N=493$ for unconstrained)																
CF_t	0.20	0.14	0.16	−0.06	0.12	0.14	0.18	0.02	0.19	−0.04	−0.42	−0.51	−0.05	−0.24	0.01	0.13
	7.65	3.66	6.35	−1.72	6.75	6.81	20.58	0.28	9.54	−0.47	−9.28	−9.07	−2.04	−3.29	2.74	7.12
CF_{t-1}	−0.07	−0.19	0.00	−0.11	0.43	0.22	0.47	0.25	0.48	0.33	0.49	0.29	−0.06	−0.10	0.01	0.07
	−4.15	−9.51	0.08	−1.85	18.58	8.68	19.17	4.64	17.67	7.70	17.18	5.85	−2.97	−2.91	1.85	4.87
MB^*_{t-1}	−0.01	0.02	0.04	0.02	0.07	0.00	0.10	0.02	0.13	0.02	0.13	0.02	0.04	0.03	0.00	−0.01
	−1.59	4.92	4.19	3.10	7.18	1.01	9.94	2.07	11.23	2.38	6.65	2.24	6.31	4.76	0.61	−2.28
R^2	0.059	0.067	0.093	0.043	0.389	0.248	0.331	0.130	0.251	0.127	0.113	0.064	0.105	0.065	0.070	0.208

(continued on next page)

TABLE 7 (continued)

Cash Flow and Investment for Constrained versus Unconstrained Firms: Correcting for Measurement Error in q (1972–2009)

	ΔCASH		ΔNWC		CAPX1		CAPX2		CAPX3		ΔDEBT2		ISSUES		DIV	
	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.
Panel C. Model 3 ($N=454$ for constrained, $N=493$ for unconstrained)																
CF_t	0.18	0.17	0.16	−0.08	0.11	0.13	0.17	0.00	0.18	−0.04	−0.44	−0.54	−0.05	−0.22	0.01	0.12
	7.95	5.56	6.22	−2.63	5.33	5.79	18.88	0.03	8.34	−0.50	−10.46	−10.10	−2.13	−3.50	2.50	7.86
CF_{t-1}	−0.13	−0.17	−0.01	−0.10	0.42	0.24	0.45	0.27	0.45	0.37	0.39	0.30	−0.07	−0.07	0.00	0.06
	−5.78	−8.29	−0.28	−1.79	19.89	8.56	29.30	4.93	21.82	8.83	11.08	7.00	−3.09	−2.04	−0.84	4.33
$CASH_{t-1}$	−0.15	−0.04	0.01	−0.05	−0.03	−0.06	0.01	−0.05	0.00	−0.03	−0.15	−0.10	−0.03	0.00	−0.04	0.00
	−10.47	−3.84	0.95	−5.52	−1.55	−15.65	0.31	−3.09	0.04	−1.83	−4.56	−5.37	−2.76	−0.20	−4.08	0.61
$DEBT2_{t-1}$	−0.02	−0.02	−0.01	−0.03	0.00	0.01	−0.01	0.00	−0.03	0.03	−0.08	−0.06	0.00	0.02	−0.01	−0.02
	−3.85	−2.80	−1.90	−3.59	0.50	0.73	−0.64	0.22	−1.91	1.81	−5.05	−5.76	0.08	2.71	−2.71	−2.19
MB^*_{t-1}	0.00	0.01	0.04	0.03	0.07	0.00	0.10	0.02	0.12	0.02	0.13	0.03	0.05	0.03	0.01	−0.01
	0.21	5.01	3.87	3.55	9.63	2.25	12.01	2.44	12.97	2.53	6.78	2.78	5.87	4.69	1.54	−2.72
R^2	0.137	0.084	0.106	0.057	0.398	0.267	0.345	0.144	0.267	0.140	0.130	0.088	0.115	0.078	0.124	0.267

and \$0.29 in Table 4.[12] The spread between the total investment–cash flow sensitivities of the two groups increases from 0.41 in Table 4 to 0.72 in Table 7 (combining spending on working capital and all fixed assets). The corresponding result is that, controlling for q, unconstrained firms are much more inclined than constrained firms to reduce debt (0.54 vs. 0.15) and equity (0.23 vs. 0.07) when cash flow increases and are much more likely to increase dividends (0.12 vs. 0.02).

In models 2 and 3 of Table 7 (the latter with cash holdings and debt included), current and lagged cash flows are both more strongly related to investment for constrained than for unconstrained firms. Focusing on model 3, the combined slope on CF_t and CF_{t-1} for constrained firms is 0.53 for capital expenditures ($t=14.94$) and 0.63 for total fixed investment ($t=33.72$), compared with estimates of 0.37 ($t=7.77$) and 0.32 ($t=2.95$), respectively, for unconstrained firms. Lagged cash flow has a stronger impact than current cash flow on investment for both groups, mirroring our earlier finding.

The bottom line is that measurement error in q seems to explain very little of the investment–cash flow sensitivity of constrained firms and only a portion (a significant fraction, to be sure) of the investment–cash flow sensitivity of unconstrained firms. The key open question is whether the remaining cash flow effect for unconstrained firms reflects lingering financing constraints for a subset of those firms or a violation of q theory, for example, because managers tend to overinvest internal funds.

VI. Conclusions

Our results suggest that investment and cash flow are strongly linked after controlling for a firm's investment opportunities, especially for firms that are the most likely to require external funds. The stronger effect for constrained firms suggests that financing frictions have a significant impact on investment decisions, but some of our results also suggest that free-cash-flow problems play a role. To be more specific, our paper reports six key findings:

i) Investment and cash flow are strongly related after controlling for MB. In our full-sample regressions, an extra dollar of cash flow is associated with \$0.14 of working capital and \$0.35 of fixed investment; a dollar of cash flow in both the current and prior years is associated with \$0.10 of working capital and \$0.50 of fixed investment. These cash flow effects are statistically and economically significant.

ii) Investment is even more strongly related to a firm's expected cash flow. Controlling for MB, past returns, cash holdings, and debt, a dollar of expected cash flow leads to an extra \$0.68 of fixed investment, compared to just \$0.12 for a dollar of unexpected cash flow. Moreover, expected cash flow drives out

[12] A curious result in model 1 of Table 7 and some of the other specifications is that the investment–cash flow sensitivities of constrained and unconstrained firms are both higher than in the full sample. For example, the CF_t slope in model 1 is 0.08 for the full sample (Table 6) but 0.35 for constrained firms and 0.14 for unconstrained firms. This finding seems to be explained by the large variation in the slope on MB_{t-1} across the different groups (variation ignored in the full-sample regression) and is not an indication that the "middle" group of firms omitted from Tables 7 and 4 is an outlier that drives the full-sample results. For example, the CF_t slope in model 1 of Table 7 equals 0.32 for the middle group, close to the estimate for constrained firms. The complete set of results for the middle group is available from the authors.

the significance of MB for the average firm and, unlike total cash flow, is positively related to new debt issuance (i.e., debt and expected cash flow seem to be complements).

iii) Firms that are the most likely to be financially constrained, as reflected in persistently negative free cash flow and low profits, working capital, dividends, and equity, are the most sensitive to cash flow. When current cash flow increases by a dollar, constrained firms spend an additional \$0.19 on working capital and \$0.53 on fixed investment, compared to estimates of \$0.02 and \$0.29, respectively, for unconstrained firms (the slopes are statistically different). The higher investment–cash flow sensitivity of constrained firms is largely driven by their reactions to unexpected cash flow.

iv) Investment is only weakly related to MB for unconstrained firms and actually becomes negatively related to MB after controlling for a firm's expected cash flow. The latter finding is difficult to reconcile either with q theory, even if MB is a noisy proxy for q, or with the mispricing view of Baker et al. (2003). It suggests that free-cash-flow problems might be severe in unconstrained firms, inducing a negative correlation between investment and firm value.

v) For unconstrained firms, a large portion of the link between investment and cash flow can be attributed to investment opportunities, that is, a connection between cash flow and q that is imperfectly captured by MB. After controlling for measurement error in MB, a dollar of cash flow in the current and prior years is associated with an additional \$0.32 of fixed investment for unconstrained firms, down from a basic estimate of \$0.53. The remaining cash flow effect for this group suggests either that a subset of the firms is misclassified as unconstrained or, consistent with the negative investment–MB relation found for these firms, that free-cash-flow problems are important.

vi) For constrained firms, very little of the investment–cash flow sensitivity seems to be explained by noise in our proxy for q. After correcting for measurement error, a dollar of cash flow in the current and prior years is associated with an additional \$0.63 of fixed investment for constrained firms, down only slightly from our basic estimate of \$0.67. The spread between the error-corrected investment–cash flow sensitivities of constrained and unconstrained firms (0.63 vs. 0.32) suggests that financing frictions have a significant impact on investment.

Collectively, our results do not fit neatly into any single model of investment. Investment opportunities are clearly important, but traditional q theory, in which q alone drives investment, is strongly rejected by the data. The costs of external financing seem to play a role, but even firms that appear to have substantial financial slack invest more when cash flow increases (even controlling for investment opportunities). And, ironically, firms that perform the best and seem the most conservative in their investment decisions, that is, firms that have high profits but generally low investment rates, are the ones that show the clearest evidence of free-cash-flow problems.

Appendix. Robustness Checks

Section V presents IV-based estimates of the investment regression using past stock returns as an instrument for q. This Appendix reports a few robustness checks using alternative instruments.

In principle, using past returns as an instrument could go awry in two ways. First, EW (2012) suggest that returns might be correlated with measurement error in MB; although, again, one of the reasons we use returns, rather than lagged MB, as an instrument is specifically because they seem less likely to be correlated with measurement error. Second, returns might enter the investment regression directly, not just through their correlation with q. For example, lagged returns should be correlated with lagged q, and if investment takes time, both current and lagged q might explain investment.

Table A1 addresses both concerns with four robustness tests. Models 1 and 2 drop returns completely from the first-stage regressions and instead use lagged cash flow or current squared cash flow as instruments; that is, the first-stage regression to get MB^*_{t-1}

TABLE A1

Robustness Checks: IV Regressions (1972–2009)

Table A1 reports average slopes, R^2s, and sample sizes from annual cross-sectional regressions. MB* is the fitted value when MB is regressed on various lags of cash flow and stock returns (instruments for q): Model 1 uses CF_t, $CF_{t-1}, \ldots, CF_{t-4}$ as instruments; model 2 uses CF_t, CF_t^2, and CF_{t-1} as instruments; model 3 uses CF_t, CF_{t-1}, and 4 lags of stock returns as instruments (for both MB_{t-1} and MB_{t-2}); and model 4 uses CF_t, CF_{t-1}, $RETURN_{t-4}$, and $RETURN_{t-5}$ as instruments. t-statistics, reported below the slope estimates, are based on the time-series variability of the estimates, incorporating a Newey–West (1987) correction with 3 lags to account for possible autocorrelation in the estimates. The sample consists of all nonfinancial firms larger than the 10th percentile of NYSE firms, as measured by net assets at the beginning of the year, and with data available for all variables within each panel. Accounting data come from Compustat, and returns come from CRSP. Variables are defined in Table 1.

	Dependent Variable							
	ΔCASH	ΔNWC	CAPX1	CAPX2	CAPX3	ΔDEBT2	ISSUES	DIV
Panel A. Model 1 (N = 1,528)								
CF_t	0.21	0.20	0.09	0.09	0.08	−0.44	−0.05	0.02
	9.49	5.94	5.54	1.78	1.53	−9.06	−1.19	3.00
CF_{t-1}	−0.08	0.14	0.14	0.25	0.31	0.38	−0.02	0.00
	−3.89	3.25	5.70	12.41	11.32	8.47	−0.54	0.05
MB^*_{t-1}	0.00	−0.03	0.02	0.03	0.03	0.03	0.00	0.01
	0.26	−3.93	3.22	3.87	3.81	2.49	−0.12	3.62
R^2	0.053	0.055	0.164	0.154	0.130	0.052	0.052	0.151
Panel B. Model 2 (N = 1,685)								
CF_t	0.20	0.24	0.09	0.15	0.12	−0.33	−0.08	0.05
	9.61	10.53	7.43	10.60	4.07	−14.68	−2.69	6.51
CF_{t-1}	−0.12	0.26	0.14	0.29	0.34	0.60	−0.08	0.04
	−3.71	3.08	4.96	10.04	9.84	10.39	−4.78	3.89
MB^*_{t-1}	0.01	−0.06	0.02	0.01	0.02	−0.03	0.02	0.00
	2.42	−4.33	3.89	1.63	3.58	−4.26	6.63	−0.08
R^2	0.061	0.085	0.160	0.146	0.130	0.060	0.059	0.148
Panel C. Model 3 (N = 1,464)								
CF_t	0.19	0.04	0.05	0.01	−0.05	−0.56	−0.17	0.07
	10.70	1.37	2.10	0.11	−0.75	−14.55	−3.13	8.36
CF_{t-1}	−0.10	−0.02	0.09	0.12	0.12	0.28	−0.16	0.07
	−5.13	−0.36	2.36	2.43	2.26	4.73	−4.25	6.83
MB^*_{t-1}	0.00	0.04	0.03	0.06	0.09	0.08	0.05	−0.01
	1.29	4.80	5.99	8.61	8.95	4.93	7.03	−2.40
MB^*_{t-2}	0.00	−0.01	0.00	−0.01	−0.01	−0.01	−0.01	0.00
	−0.25	−4.97	−0.09	−1.04	−0.75	−2.14	−2.17	0.09
R^2	0.057	0.072	0.189	0.180	0.156	0.075	0.071	0.204
Panel D. Model 4 (N = 1,396)								
CF_t	0.17	0.10	0.09	0.10	0.06	−0.47	−0.13	0.07
	7.87	3.02	2.21	1.87	0.67	−10.17	−1.99	5.92
CF_{t-1}	−0.14	0.03	0.15	0.23	0.27	0.39	−0.13	0.07
	−8.33	0.71	4.07	4.64	4.74	6.86	−2.57	5.76
MB^*_{t-1}	0.01	0.01	0.01	0.02	0.03	0.02	0.03	−0.01
	3.17	1.07	1.07	1.29	1.34	1.55	1.98	−1.63
R^2	0.053	0.053	0.172	0.158	0.136	0.056	0.050	0.182

includes $CF_t, CF_{t-1}, \ldots, CF_{t-4}$ in model 1 and CF_t, CF_t^2, and CF_{t-1} in model 2. (As discussed in Section V, CF_t^2 is a valid instrument under the assumptions of EW's (2012) higher-moment estimator but does not require the data to be independent and identically distributed.) Model 3 uses the same instruments as Table 6 (CF_t, CF_{t-1}, and 4 lags of stock returns) but adds MB_{t-2} to the regression to address the possibility that lagged q might enter the regression (we instrument for both MB_{t-1} and MB_{t-2}). Model 4 drops the most recent 3 years of returns from the set of instruments, the logic being that more distant returns are the least likely to correlate with measurement error in MB (the first-stage regression includes CF_t, CF_{t-1}, and lags 4 and 5 of returns). All four tests confirm that cash flow remains significant after controlling for measurement error in MB. Investment–cash flow sensitivities in model 3 are very similar to those reported in Section V, whereas investment–cash flow sensitivities in models 1, 2, and 4 are substantially higher.

The conclusions from Table A1 also carry over to the constrained and unconstrained subsamples: Cash flow effects in our four robustness checks are large, significant, and often greater than those reported in Section V (and never significantly lower). Details are available from the authors.

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