Investment and cashflow: New evidence

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Abstract

We study the investment-cashflow sensitivities of U.S. firms from 1971–2009. Our tests extend the literature in several key ways and provide strong evidence that cashflow explains investment beyond its correlation with Q. In simple OLS regressions, a dollar of current- and prior-year cashflow is associated with $0.53 of additional investment for firms that are the least likely to be constrained and $0.67 for firms that are the most likely to be constrained. Investment-cashflow sensitivities for the two groups drop to a conservatively estimated but still significant 0.32 and 0.63, respectively, after correcting for measurement error in M/B. Our results suggest that financing constraints and free cashflow problems are important for investment decisions.

1. 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 cashflow. Theoretically, a firm might invest more when cashflow is high for three reasons: (i) internal funds may be less costly than external funds; (ii) managers may tend to overspend internally available funds; and (iii) cashflow may simply be correlated with investment opportunities.

Empirically, investment and cashflow are significantly related, though both the strength of the relationship and its cause are the subject of much debate. For example, Fazzari, Hubbard, and Petersen (1988) and Kaplan and Zingales (1997) estimate investment-cashflow sensitivities of 0.20–0.70 for manufacturing firms 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-cashflow 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 Jr. (2010), and Erickson and Whited (2012) estimate investment-cashflow sensitivities of just 0.01–0.09, while Chen and Chen (2012) find that investment-cashflow sensitivities have 'completely disappeared in recent years' (p. 394). In short, while there remains disagreement about why investment and cashflow are related, much of the recent literature suggests that cashflow has, at most, a small impact on investment.

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

(1) We introduce a new measure of cashflow that is significantly better than the measure commonly used in the literature (income before extraordinary items plus depreciation). The standard measure has become substantially noisier over time because it 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-cashflow sensitivities estimated in our sample (1971–2009).

(2) We employ several new IV estimators to correct for measurement error in a firm's market-to-book ratio (M/B), our proxy for Q. Our IVs address limitations of existing estimators. For example, most IV estimators in the literature are based on lagged M/B and, as Erickson and Whited (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 cashflow, to get around this concern. An alternative approach used in the literature, the Erickson-Whited (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 2012)—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 EW's minimum-distance approach). We show that one of our IV estimators is valid under EW's assumptions but does not require the data to be i.i.d. 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.

(3) We study how investment relates to both current and lagged cashflow. The contemporaneous link between investment and cashflow 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 cashflow (which

is highly correlated with lagged cashflow). In fact, investment is more strongly related to lagged than to current cashflow, and adding lagged cashflow to the regressions significantly raises estimates of investment-cashflow sensitivities.

(4) We study all of the ways firms spend cashflow, 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 (PP&E) 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 cashflow. 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 cashflow.[1]

(5) We offer a new way to sort firms into financially constrained and unconstrained groups based on forecasts of a firm's free cashflow. Our goal here is more to identify unconstrained firms with lots of excess cash than to identify firms that are unambiguously constrained (something that is harder to do). In the three years leading up to the sort, the unconstrained group has high and increasing sales, profits, cashflow, returns, and cash holdings but low and decreasing debt and investment. Cashflow 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 exceed their total liabilities, and the firms could pay down debt with just over one year of cashflow. This group allows us to explore investment-cashflow sensitivities for firms that, by all appearances, seem to be financially unconstrained.

Our results suggest that investment and cashflow are strongly linked after controlling for a firm's investment opportunities. For the full sample of firms, basic OLS investment regressions—i.e., with no correction for measurement error in Q—show that an additional dollar of cashflow 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

[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 cashflow, their tests appear to track only a portion what firms do with cashflow. For example, the slopes in their 'unconstrained' regressions suggest that their variables capture roughly 60–80% of a firm's cash expenditures (see their Table V, columns (1) and (3)).

($0.13), and dividends ($0.06). (The effects, all highly significant, sum to slightly less than one because of so-called 'dirty surplus' accounting.) The prior year's cashflow is even more strongly related to investment and, together, an additional dollar of cashflow in the current and prior year is associated with an extra $0.60 of total investment. These cashflow effects are much stronger than found in the recent literature, due in part to the data refinements discussed earlier.

Interestingly, lagged cashflow is significant even 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., the impact of lagged cashflow does not work through its effects on a firm's cash and debt positions). One interpretation is that high prior-year cashflow raises managers' expectation of current cashflow, and it is this expected, rather than total, cashflow that drives investment. In fact, when we break cashflow into expected and unexpected components, we find that a dollar of expected cashflow leads to an additional $0.68 of fixed investment compared to just $0.12 for unexpected cashflow. Further, unexpected cashflow is largely used to reduce debt (–$0.47) while higher expected cashflow 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, Levy, and Whited (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 cashflow: capital expenditures increase by $0.28 for unconstrained firms and $0.41 for constrained firms when current cashflow increases by a dollar. However, total investment by constrained firms, including spending on working capital and all types of fixed assets, goes up $0.72 for each extra dollar of cashflow, 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 cashflow compared to $0.50 for unconstrained firms. These disparities are largely driven by the groups' differential response to unexpected cashflow.

A sizable fraction of the link between investment and cashflow can be attributed to measurement error in Q, but we strongly reject the joint hypothesis that investment is linear in Q and cashflows are important only because M/B measures Q with error. Focusing on total fixed investment, the slope on current-year cashflow 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 M/B. The slope on prior-year cashflow 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-cashflow sensitivity of unconstrained firms but little of the investment-cashflow 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-cashflow 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 2 reviews Q theory; Section 3 describes the data; Section 4 reports OLS investment regressions and Section 5 explores the impact of measurement error in Q; Section 6 concludes.

2. 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

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

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

$$1 + C_I(I_t,K_t,\lambda_t) = \beta\, E_t[V_K(K_{t+1},s_{t+1},\lambda_{t+1})], \quad (2)$$

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, e.g.,

$$C = .5\,\alpha\,(I_t/K_t - \lambda_t)^2\,K_t, \tag{3}$$

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

$$I_t/K_t = -(1/\alpha) + (1/\alpha)\,Q_t + \lambda_t. \tag{4}$$

The most common empirical proxy for Q is some form of M/B ratio for assets or capital. In truth, M/B is likely to be a better measure of average than marginal Q, but Hayashi (1982) shows 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 random noise, eq. (4) can be interpreted as a regression equation, 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 cashflow, or any other measure of net worth or liquidity, after controlling for Q.

On the other hand, cashflow might be important if the firm faces financing constraints, short-hand 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, since it ignores adjustment costs, but should capture the first-order effects pretty well):

$$FC_t = .5\,b\,(I_t/K_t - \Pi_t/K_t)^2\,K_t \quad \text{if} \quad I_t > \Pi_t, \tag{5}$$

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

$$1 + \alpha\,(I_t/K_t - \lambda_t) + b\,(I_t/K_t - \Pi_t/K_t) = Q_t \tag{6}$$

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

$$I_t/K_t = \frac{-1}{\alpha + b} + \frac{1}{\alpha + b} Q_t + \frac{b}{\alpha + b} \Pi_t/K_t + \frac{\alpha}{\alpha + b} \lambda_t. \tag{7}$$

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 zero. 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.

3. Data

Our tests use all nonfinancial firms on Compustat, merged with CRSP to get annual stock returns. 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 NYSE 10th percentile measured by net assets at the beginning of the year.[2]

3.1. Variable definitions

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

Net assets = cash + net working capital (NWC) + PP&E + other fixed assets, (8)

Net assets = debt + equity. (9)

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 eq. (9). Our proxy for Q is the market-to-book ratio of net assets.

Cashflow is typically measured as income before extraordinary items ('profits') plus depreciation, a measure that has at least four problems. First, and most obviously, it misses the cashflow effects of extraordinary items. Second, it wrongly 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). Third, profits include gains and losses from the sale of PP&E, which are better classified as (negative) investments than as operating

[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-PP&E firms in order to eliminate firms for whom capital expenditures are not important. Again, results for that sample are very similar to those reported below. Details are available upon request.

cashflows. 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 cashflow, CF, using data from the Statement of Cash Flows (SCF). Like the traditional measure, we start with income before extraordinary items plus depreciation (taken 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 PP&E, and other funds from operations identified in the SCF.[3] Our procedure mimics the definition of operating cashflow in the SCF except that it excludes spending on working capital, which we view as a component of investment.

Fig. 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. While both measures become more volatile over time, the relative volatility of Prof+Depr increases rapidly in the 1990 and spikes dramatically in 2000–2002 and 2008. The patterns suggest that Prof+Depr becomes a noisier measure of cashflow during the second half of the sample, largely due to an increase in noncash special items. As we discuss further below, this fact helps to explain why recent studies tend to estimate low investment-cashflow sensitivities (see the Introduction).

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 long-term 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 (since our goal is to measure actual expenditures). An important point is that Capx3 reflects all acquisitions, whereas the item 'acquisitions' on Compustat only picks

[3] The last item adjusts for asset write-downs. The precise definition is: 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 PP&E) + FOPO (funds from operations–other). All of these items come from the SCF.

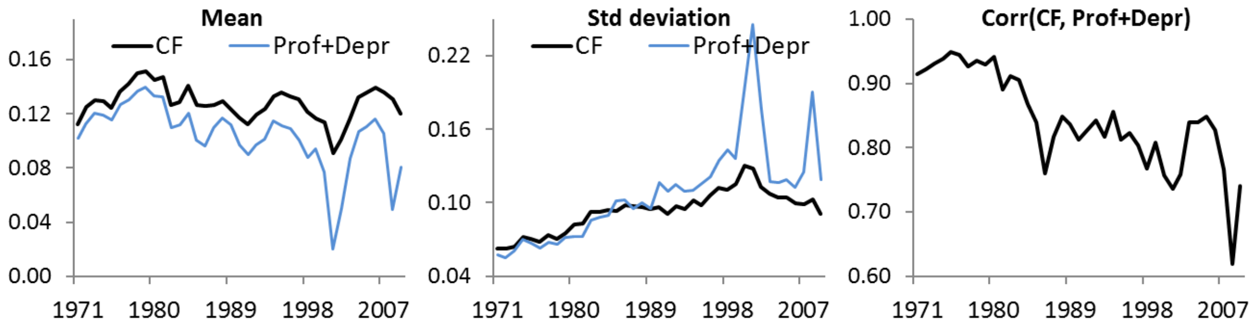

Fig. 1. Annual cross-sectional mean, standard deviation, and correlation of cashflow (CF) and income before extraordinary items plus depreciation (Prof+Depr). The variables are scaled by average net assets during the year and winsorized at their 1st and 99th percentiles. Data come from Compustat. The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

up 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.

One of our goals is to provide a complete picture of what firms do with cashflow. In addition to buying fixed assets, a firm can use cashflow to increase cash holdings, to invest in NWC, to pay down debt, to repurchase shares, and to pay dividends. The first three are measured as changes in cash holdings (dCash), working capital (dNWC), and debt (dDebt) during the year (debt includes long-term deferred taxes, so we adjust dDebt 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 eqs. (8) and (9), the following relation holds approximately in the data:

$$\text{CF} \approx \text{dCash} + \text{dNWC} + \text{Capx3} - \text{dDebt} - \text{Issues} + \text{Div}. \quad (10)$$

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

We scale all level variables—cash, NWC, 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 cashflow 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 cashflow of 2.0%, implying that total cashflow 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 long-term investment. Adding in working capital, firms invest 15.2% of net assets in an average year, 2.4% more than cashflow. Firms also use cashflow 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).

3.2. 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 possible 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, though 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]

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[4] To the extent our classification scheme works, we side-step the concerns of Kaplan and Zingales (1997), who argue that investment-cashflow sensitivities do not have to be lower for moderately constrained vs. highly constrained firms. (This point can be seen in eq. 7 of our model, which shows that cashflow has the same impact on investment for any positive amount of external financing.) For our purposes, the more important prediction is that cashflow 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-cashflow 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.

Table 1
Descriptive statistics, 1971–2009

This table 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, while all level variables are scaled by ending net assets (net assets equal total assets minus non-debt 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.

Variable	Description	Mean	Median	Std	Min	Max	N
OpProf	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 cashflows[1]	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	Non-cash net working capital[2]	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[3]	0.686	0.704	0.236	0.143	1.081	1,799
Debt1	Short-term + 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
dNA	Change in net assets	0.081	0.068	0.203	-0.582	0.780	1,817
dCash	Change in cash holdings	0.010	0.003	0.082	-0.256	0.338	1,806
dDebt2	Change in Debt2	0.037	0.015	0.148	-0.408	0.612	1,812
dToteq	Change in Toteq	0.042	0.040	0.140	-0.497	0.511	1,812
Inteq	Internal equity[4]	0.024	0.036	0.108	-0.478	0.262	1,811
Issues	Share issuance[5]	0.026	0.004	0.087	-0.174	0.455	1,799
Capx1	Capital expenditures (net)[6]	0.089	0.070	0.076	-0.027	0.410	1,801
Capx2	Capx1 + other investments[7]	0.116	0.091	0.121	-0.176	0.605	1,801
Capx3	Total investment in fixed assets[8]	0.141	0.109	0.158	-0.284	0.788	1,757
Capx4	Total investment[9]	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
M/B	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

[1] OthCF = Operating cashflows other than income, depreciation, and working capital from the Statement of Cash Flows
[2] NWC = current assets – cash – non-debt current liabilities
[3] FA = total assets – current assets
[4] Inteq = NI – DIV
[5] Issues = dToteq – change in retained earnings
[6] Capx1 = capital expenditures – sale of PP&E
[7] Capx2 = Capx1 + other investing activities from the Statement of Cash Flows
[8] Capx3 = dFA + depr – other non-cash adjustments to FA from the Statement of Cash Flows
[9] Capx4 = Capx3 + dNWC

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

Expected free cashflow comes from a cross-sectional regression of FCF1 on lagged firm characteristics. Since 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, stock returns, investment (Capx1, Capx3, dNWC), dividends, debt, M/B, sales, PP&E, depreciation, and the level of and change in cash holdings. 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 1/3 firms as 'unconstrained' and the bottom 1/3 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, cashflow, dividends, cash holdings, and stock returns. They have relatively little debt and invest significantly less than constrained firms in all three 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%. Cashflow for unconstrained firms exceeds capital expenditures by 10.1%, 11.1%, and 13.2% of net assets in the three years leading up to the sort and exceeds total investment by an average of 2.1% of net assets. These patterns suggest

[5] The breakpoints change annually to keep 1/3 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 below.

Table 2
Descriptive statistics: Constrained vs. unconstrained firms, 1971–2009
This table compares the characteristics of constrained and unconstrained firms. The groups are defined at the end of year 0 based on expected free cashflow in year +1 (predicted in a cross-sectional regression of FCF1 on lagged firm characteristics); unconstrained firms represent the top 1/3 of firms ranked on this measure and constrained firms represent the bottom 1/3. 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.

	Constrained					Unconstrained				
Year	-2	-1	0	+1	+2	-2	-1	0	+1	+2
OpProf	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
dNA	0.162	0.165	0.154	0.054	0.041	0.128	0.123	0.114	0.120	0.105
dDebt2	0.025	0.022	0.013	-0.001	0.004	0.024	0.027	0.028	0.019	0.014
dCash	0.068	0.078	0.098	0.041	0.026	0.032	0.028	0.014	0.041	0.043
dToteq	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
M/B	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

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

4. Basic investment regressions

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

4.1. Methodology

Our main tests focus on average slopes from 39 annual cross-sectional regressions, 1971–2009. We report standard errors based on the time-series variability of the slopes, incorporating a Newey-West correction with three lags to account for possible autocorrelation in the estimates. This approach has the advantage that it allows investment-cashflow sensitivities to vary over time and corrects very simply for both time-series and cross-sectional dependence in the data.[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 five years of data, and found very similar cashflow effects to those reported. Any differences are noted in the text.

4.2. Results

Table 3 shows regressions for the full sample. The dependent variables include our three long-term investment measures—capital expenditures (Capx1), all investing activities from the SCF (Capx2), and all purchases of fixed assets (Capx3)—along with changes in cash holdings (dCash), investments in working capital (dNWC),

[6] Petersen (2009) shows that autocorrelation-adjusted Fama-MacBeth (1973) standard errors may not fully capture serial correlation arising from firm fixed effects, though 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 below, probably because they do not reflect time-variation in the true slopes that is captured by our Fama-MacBeth procedure.

changes in debt (dDebt2), net share issuance (Issues), and dividends (Div). Together, these provide a nearly complete picture of how firms spend cashflow.

Model 1 is the most basic investment model, with CF_t and M/B_{t-1} as the only regressors (our use of lagged M/B follows the convention in the literature). In these regressions, CF is strongly linked to both short-term and long-term investment: a dollar of cashflow 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 cashflow 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 statistically significant. Like our earlier descriptive statistics, the slopes for dDebt2 and Issues provide little evidence that debt is the more important source of external funds.

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

Model 2 adds current and lagged stock returns to the regressions. Returns in the prior two years are strongly related to investment but have little impact on the estimated cashflow effects. The significance of returns is important because it provides a strong clue that M/B measures Q with error—if not, M/B should subsume the explanatory power of past returns (returns could also be related to financing constraints, but that relation seems likely to be weaker than their correlation with investment opportunities).

Model 3 adds lagged cashflow 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 cashflow. 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 cashflow is important only through its impact on the firm's financial position.

Table 3
Investment and cashflow, 1971–2009
This table 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 correction with three lags to account for possible autocorrelation in the estimates. Flow variables other than stock returns are scaled by average net assets during the year, while 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.

	Dependent variable							
	dCash	dNWC	Capx1	Capx2	Capx3	dDebt2	Issues	Div
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
M/B_{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
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
M/B_{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
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
M/B_{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

Table 3, cont.

	Dependent variable							
	dCash	dNWC	Capx1	Capx2	Capx3	dDebt2	Issues	Div
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
M/B_{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

dCash = change in cash holdings
dNWC = change in non-cash net working capital
Capx1 = net capital expenditures
Capx2 = all investing activities from the Statement of Cash Flows (SCF)
Capx3 = change in fixed effects + depr – other non-cash adjustments to fixed assets from the SCF
dDebt2 = change in total nonoperating liabilities
Issues = change in shareholders equity – change in retained earnings
Div = cash dividends (common + preferred)
CF = income before extraordinary items + depreciation + other operating cashflow
M/B = market-to-book ratio of net assets
Return = annual stock return

Lagged cashflow turns out to be strongly related to investment. Controlling for the other regressors, an extra dollar of prior-year cashflow 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 cashflow drops significantly with lagged cashflow 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]

[7] We have also estimated specifications with lagged investment as a control variable. Cashflow 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, since higher cashflow 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.

Prior-year cashflow 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 cashflow. At first glance, the financing-constraints story seems hard to reconcile with the fact that CF_{t-1} is significant after controlling for cash holdings, debt, and current cashflow, 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* cashflow 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 cashflow and an indirect role through expectations: cashflow is highly persistent, so lagged and expected cashflow 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 to facilitate an interpretation of the results in terms of expected and unexpected cashflows: 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 cashflows, respectively. In addition, the slopes on lagged M/B, returns, cash holdings, and debt now show how those variables correlate with investment after controlling for their association with expected cashflow.

The results are reported as Model 4. Unexpected cashflow, $U[CF_t]$, 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 cashflow, $E[CF_t]$, raises investment almost one-for-one: a dollar of expected cashflow 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-cashflow sensitivity of nearly 0.80. Moreover, expected cashflow and debt seem to be complements—a dollar of expected cashflow is associated with $0.09 of new debt—in contrast to the strong substitution effect found for unexpected cashflow (-$0.47). These results are consistent with Q theory, to the extent that expected cashflow captures variation in Q missed by M/B, but are also consistent with expected cashflow having both a direct effect on financing frictions and an indirect effect through the relaxation of borrowing constraints.

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

Fig. 2 illustrates how investment-cashflow sensitivities change through time and compares the results to those using the conventional proxy for cashflow, income before extraordinary items plus depreciation (Prof+Depr). Investment-cashflow 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 six). 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 cashflow after 1985 (see Fig. 1).

The downward trend in the slope on Prof+Depr mimics the findings of Chen and Chen (2012), who conclude that investment-cashflow 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 cashflow through time (see Fig. 1).

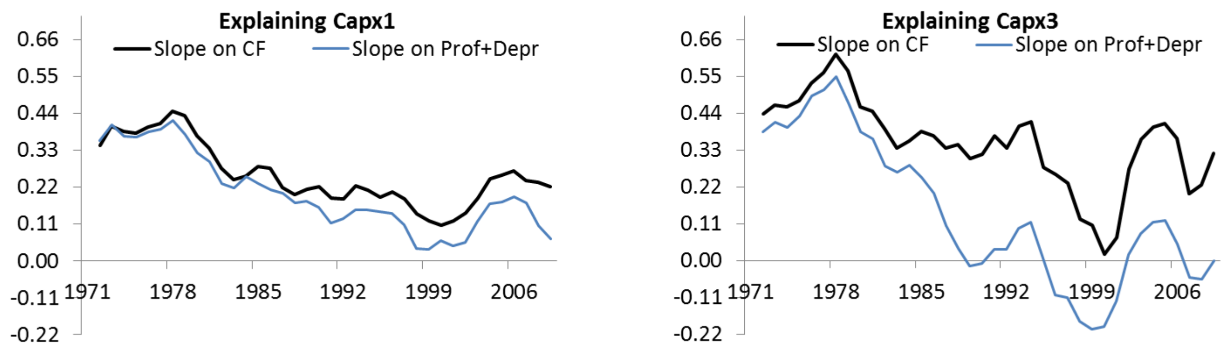

Fig. 2. Investment-cashflow sensitivities, 1971–2009, estimated as the two-year rolling average of the slopes on cashflow (CF) and income before extraordinary items plus depreciation (Prof+Depr) when capital expenditures (Capx1) and total fixed investment (Capx3) are regressed on each variable and M/B. 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.

4.3. Constrained vs. unconstrained firms

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

Controlling just for M/B, 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 cashflow, compared with cashflow 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-cashflow 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 cashflow. Both groups increase their cash holdings by roughly \$0.15 for each additional dollar of cashflow.

Investment by constrained firms is also much more sensitive to M/B, consistent with the findings of Baker, Stein, and Wurgler (2003). Constrained firms have a M/B slope that is more than ten times larger for capital expenditures (0.040 vs. 0.003) and five 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 M/B is a good proxy for Q, since unconstrained firms should react more aggressively to changes in investment opportunities (see our model in Section 2). 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 included in the regression (Model 2): the slopes on CF and M/B drop slightly in the investment regressions relative to Model 1 but the comparison across groups does not change. And past returns, like M/B, 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 includes lagged cashflow, cash holdings, and debt in the regressions. Lagged cashflow is highly significant and, unlike current cashflow, has about the same impact on investment for the two groups: an additional dollar of prior-year cashflow 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 reinterprets the role of lagged cashflow via its impact on expected cashflow. As we did for the full sample, we replace CF_{t-1} and CF_t with expected and unexpected cashflow, respectively (estimated in separate first-stage regressions for constrained and unconstrained firms). Fixed investment increases almost one-for-one with expected cashflow for both constrained (\$0.91) and unconstrained (\$0.84) firms, the majority of which represents increases in capital expenditures. Unexpected cashflow has a smaller impact on investment but helps to drive the different investment-cashflow 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 cashflow, compared with insignificant effects of -\$0.02 and \$0.00, respectively, for unconstrained firms. The slopes on cash holdings are also significant for constrained firms and close to zero for unconstrained firms. The differential effect is consistent with financing constraints, but the slopes on lagged debt do not exhibit a

Table 4
Cashflow and investment for constrained vs. unconstrained firms, 1972–2009
This table reports average slopes, R^2s, and sample sizes (N) from annual cross-sectional regressions for constrained and unconstrained 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 correction with three lags to account for possible autocorrelation in the estimates. The groups are determined at the beginning of the year based on expected free cashflow 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.

	dCash		dNWC		Capx1		Capx2		Capx3		dDebt2		Issues		Div	
	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.
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
M/B_{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
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
M/B_{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
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
M/B_{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
$Cash_{t-1}$	-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

Table 4, cont.

	dCash		dNWC		Capx1		Capx2		Capx3		dDebt2		Issues		Div	
	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.
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
M/B_{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

dCash = change in cash holdings
dNWC = change in non-cash net working capital
Capx1 = net capital expenditures
Capx2 = all investing activities from the Statement of Cash Flows (SCF)
Capx3 = change in fixed effects + depr – other non-cash adjustments to fixed assets from the SCF
dDebt2 = change in total nonoperating liabilities
Issues = change in shareholders equity – change in retained earnings
Div = cash dividends (common + preferred)
CF = income before extraordinary items + depreciation + other operating cashflow
M/B = market-to-book ratio for net assets
Return = annual stock return, contemporaneous and lagged 1 and 2 years

corresponding pattern.

Perhaps the most surprising result from Model 4 is that, after controlling for expected cashflow, investment is negatively related to M/B 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 cashflow problems might be so severe among unconstrained firms that higher investment actually reduces firm value.

Overall, Tables 3 and 4 provide strong evidence that cashflow is significantly related to investment after controlling for M/B and stock returns. The effects are economically large, implying that spending increases by $0.51 for unconstrained firms and $0.84 for constrained firms when current- and prior-year cashflows increase by one dollar (Model 3 in the tables).

5. Measurement error in Q

In principle, investment opportunities could explain many of the cashflow effects above if M/B is a noisy proxy for Q. Measurement error in M/B 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.

5.1. Methodology

Our goal here is to estimate an empirical version of eq. (7), i.e.,

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

recognizing that M/B is an imperfect proxy for Q:

$$\text{M/B} = g_0 + g_1 \text{Q} + \eta. \tag{12}$$

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 the lagged level, or change in, M/B as an instrument. However, as noted by Almeida, Campello, and Galvao (2010) and Erickson and Whited (2012), that approach requires 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 M/B 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 M/B on cashflow and lagged returns. The fitted value from this regression then replaces Q in eq. (11), yielding a consistent estimate of c_2 under the assumption that returns and cashflow 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, $M/B = \delta_0 + \delta_1'x + \omega$, are proportional to those when Q is regressed on x, with constant of proportionality g_1 from eq. (12). In addition,

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

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 eq. (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 (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. If so, our tests actually provide a *downward*-biased estimate of the slope on cashflow, which turns out not to be a big problem for our conclusions because cashflow effects remain significant anyway.[8] In a sense, our results may well be conserv-ative in that they might attribute too much of the cashflow effects to investment opportunities and too little to financing frictions (while OLS regressions likely do the opposite).

Using past returns as instruments for Q could also be problematic for at least two reasons. First, Erickson and Whited (EW 2012) suggest that returns might be correlated with measurement error in M/B—though, again,

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

we use lagged returns, rather than lagged M/B, specifically because returns do not depend on the book value of assets and seem less likely to correlate with η. Second, 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 (eq. 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 cashflow or current squared cashflow as instruments for Q (the second of these is discussed further below). (ii) We continue to use returns but add M/B_{t-2} to the investment regressions to address the possibility that lagged Q might enter the regression (we instrument for both M/B_{t-1} and M/B_{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 M/B. The upshot is that the results reported in the text seem to provide, in anything, conservative estimates of cashflow 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 the assumptions used to derive the EW estimator but simply obtain identification differently. As a quick review, EW start with same basic model that we consider:

$$INV = c_0 + c_1 Q + c_2 CF + \varepsilon, \quad (14)$$

$$M/B = g_0 + g_1 Q + \eta. \quad (15)$$

Rather than instrument for Q, they derive a GMM-based higher-moment estimator under the assumption that η and ε are statistically independent of each other and of CF and Q.[9] Identification in their context requires that the appropriate higher moments are not zero. Given the same independence assumption, squared CF is a valid instrument for Q, where identification now requires that CF^2 correlates with Q. Further, if independence holds

[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 $\varepsilon_{M/B}$, when INV and M/B are regressed on CF and a constant. The second step is to estimate the moments $E[\varepsilon_{INV}^2\varepsilon_{M/B}]$ and $E[\varepsilon_{INV}\varepsilon_{M/B}^2]$, the ratio of which, under the independence assumption above, provides a consistent estimator of c_1 (for identification, the moment used in the denominator, $E[\varepsilon_{INV}\varepsilon_{M/B}^2]$, cannot be zero). Third, given c_1, the slope on CF is obtained using basic regression identities that relate the slopes in the multiple regression (14) to the slopes in the simple regressions estimated in step 1.

on a lead-lag basis—if η is uncorrelated with both current and prior CF—lagged CF is also a valid instrument for Q. Thus, our IV estimators in the Appendix provide a simple way to exploit EW's independence assumption without requiring some of their other assumptions. Again, we use returns as an instrument in the main text because it provides the most conservative estimates.

5.2. Results

Table 5 reports the first-stage regressions of M/B on cashflow and returns. CF_t by itself explains 23% of the variation in M/B 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, since cashflow for that group is, at once, strongly related to investment but weakly related to Q.

The remaining columns in Table 5 add lagged cashflow and returns to the regression. Current- and prior-year CF are strongly related to M/B, with individual slopes that roughly split the slope on cashflow in Model 1 of the table. Returns up to four 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 M/B that is orthogonal to cashflow. Thus, the fitted value from the regressions—our instrument for Q—has sufficiently low correlation with cashflows 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 M/B but reduce the number of firms with data. For our subsequent tests, we include all four 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 M/B_{t-1} in the regression, is the direct analog of Model 1 in Table 3. After correcting for measurement error, an extra dollar of cashflow is associated with \$0.08 of capital expenditure (t=3.46) and

[10] We find similar results if we instead use three or five returns lags in the first-stage regression. Cashflow 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 M/B that is orthogonal to cashflow.

Table 5
Explaining Q, 1971–2009
This table reports average slopes, R^2s, and sample sizes from annual cross-sectional regressions of firms' M/B ratios at the end of year t-1 on cashflow (CF) and returns. t-statistics, reported below the slopes, are based on the time-series variability of the estimates, incorporating a Newey-West correction with three lags. The full sample ('All') includes all nonfinancial firms larger than the NYSE 10th percentile of net assets. The constrained ('Cons.') and unconstrained subsamples ('Unc.') are determined at the beginning of the year based on the firm's predicted cashflows in excess of capital expenditures (unconstrained firms represent the top 1/3 of firms ranked on this measure, while constrained firms represent the bottom 1/3). 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

$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-cashflow sensitivity drops from 0.49 in Table 3 to just 0.04 here. Thus, a significant portion of the cashflow effects estimated earlier can be attributed to a correlation between cashflow and Q.[11] After controlling for Q, cashflow 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), effects that are all highly significant.

Model 2 adds lagged cashflow to the regression. The slopes on lagged cashflow 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 cashflow, an extra dollar of prior-year cashflow is associated with

[11] This is one instance where adjusting for firm fixed effects makes a difference (see our discussion in Section 4.1). 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 (the t-stat drops from 11.17 to 5.19), from 0.20 to 0.08 for capital expenditures (the t-stat drops from 8.83 to 4.32), and from 0.33 to 0.09 for total fixed investment (the t-stat drops from 11.55 to 2.74).

Table 6
Investment and cashflow: Correcting for measurement error in Q, 1972–2009

This table reports average slopes, R^2s, and sample sizes (N) from annual cross-sectional regressions. M/B* is the fitted value when M/B is regressed on current and lagged cashflow (CF_t and CF_{t-1}), four 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 correction with three lags to account for possible autocorrelation in the estimates. Flow variables are scaled by average net assets during the year, while 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 asssets at the beginning of the year, and with data available for all variables within each panel.

	Dependent variable							
	dCash	dNWC	Capx1	Capx2	Capx3	dDebt2	Issues	Div
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
M/B_{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
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
M/B_{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
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
M/B_{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

dCash = change in cash holdings
dNWC = change in non-cash net working capital
Capx1 = net capital expenditures
Capx2 = all investing activities from the Statement of Cash Flows (SCF)
Capx3 = change in fixed effects + depr – other non-cash adjustments to fixed assets from the SCF
dDebt2 = change in total nonoperating liabilities
Issues = change in shareholders equity – change in retained earnings
Div = cash dividends (common + preferred)
CF = income before extraordinary items + depreciation + other operating cashflow
M/B = market-to-book ratio for net assets

\$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 cashflow relates to investment opportunities, but cashflow also seems to have a direct impact on investment, consistent with a role for financing frictions.

For completeness, Model 3 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 cashflow 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 M/B does not fully explain the cashflow 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, with just CF and $M/B_{t-1}*$ 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 cashflow, 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 and \$0.29 in Table 4.[12] The spread between the total investment-cashflow 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

[12] A curious result in Model 1 and some of the other specifications is that investment-cashflow 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 M/B_{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 4 and 7 is an outlier that drives the full-sample results. For example, the CF_t slope in Model 1 equals 0.32 for the middle group, close to the estimate for constrained firms. The complete set of results for the middle group are available on request.

Table 7

Cashflow and investment for constrained vs. unconstrained firms: Correcting for measurement error in Q, 1972–2009

This table reports average slopes, R^2s, and sample sizes (N) from annual cross-sectional regressions for constrained and unconstrained firms. M/B* is the fitted value when M/B is regressed on current and lagged cashflow (CF_t and CF_{t-1}), four 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 correction with three lags to account for possible autocorrelation in the estimates. Flow variables are scaled by average net assets during the year, while 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 asssets at the beginning of the year, and with data available for all variables within each panel. The variables are defined in Table 1.

	dCash		dNWC		Capx1		Capx2		Capx3		dDebt2		Issues		Div	
	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.	Cons.	Unc.
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
M/B_{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
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
M/B_{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
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
M/B_{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

inclined than constrained firms to reduce debt (0.54 vs. 0.15) and equity (0.23 vs. 0.07) when cashflow increases, and are much more likely to increase dividends (0.12 vs. 0.02).

In Models 2 and 3 (the latter with cash holdings and debt included), current and lagged cashflows 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 cashflow has a stronger impact than current cashflow 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 cashflow sensitivity of constrained firms and only a portion—a significant fraction to be sure—of the investment-cashflow sensitivity of unconstrained firms. The key open question is whether the remaining cashflow 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.

6. Conclusions

Our results suggest that investment and cashflow 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 cashflow problems play a role. To be more specific, our paper reports six key findings:

(1) Investment and cashflow are highly correlated after controlling for M/B. In our full sample, an extra dollar of current cashflow is associated with a $0.14 of working capital and $0.35 of total fixed investment. A dollar of cashflow in both the current and prior years is associated with an extra $0.10 of working capital and $0.50 of total fixed investment (controlling for M/B, past returns, cash holdings, and debt). These cashflow effects are statistically significant and economically large.

(2) Investment is more strongly related to a firm's expected cashflow than to its total cashflow. Controlling for M/B, past returns, cash holdings, and debt, a dollar of expected cashflow leads to an extra $0.68 of total fixed investment, compared to just $0.12 for a dollar of unexpected cashflow. Moreover, expected cashflow drives out the significance of M/B for the average firm and, unlike total cashflow, is positively related to new debt issuance (i.e., debt and expected cashflow seem to be complements).

(3) Firms that are the most likely to be financially constrained—as reflected in persistently negative free cashflow and low profits, working capital, dividends, and equity—are the most sensitive to cashflow. When current cashflow 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-cashflow sensitivity of constrained firms is largely driven by their reaction to unexpected cashflow.

(4) Investment and M/B are only weakly related for unconstrained firms and actually become negatively related after controlling for a firm's expected cashflow. The latter finding is difficult to reconcile either with Q theory—even if M/B is a noisy proxy for Q—or with the mispricing view of Baker, Stein, and Wurgler (2003). It suggests that free cashflow problems might be severe in unconstrained firms, inducing a negative correlation between investment and firm value.

(5) For unconstrained firms, a large portion of the link between investment and cashflow can be attributed to investment opportunities, i.e., a connection between cashflow and Q that is imperfectly captured by M/B. After controlling for measurement error in M/B, a dollar of cashflow 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 cashflow effect for this group suggests either that a subset of the firms are misclassified as unconstrained or, consistent with the negative investment-M/B relation found for these firms, that free cashflow problems are important.

(6) For constrained firms, very little of the investment-cashflow sensitivity seems to be explained by noise in

our proxy for Q. After correcting for measurement error, a dollar of cashflow 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 error-corrected spread in investment-cashflow sensitivities between constrained and unconstrained firms, equal to 0.31 (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 cashflow increases (even controlling for investment opportunities). And, ironically, firms that perform the best and seem the most conservative in their investment decisions—i.e., firms that have high profits but generally low investment rates—are the ones that show the clearest evidence of free cashflow problems.

Appendix

Section 5 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, Erickson and Whited (2012) suggest that returns might be correlated with measurement error in M/B—though, again, one of the reasons we use past returns, rather than past M/B, is specifically because they seem less likely to be correlated with measurement error in M/B_t. 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 cashflow (Model 1) or current squared cashflow (Model 2) as instruments, i.e., the first-stage regression to get M/B_{t-1}* includes CF_t, CF_{t-1}, … CF_{t-4} in Model 1 and CF_t, CF_t^2, and CF_{t-1} in Model 2. (As discussed in Section 5, CF_t^2 is a valid instrument under the assumptions of EW higher-moment estimator but does not require the data to be i.i.d.) Model 3 uses the same instruments as Table 6 (CF_t, CF_{t-1}, and four lags of stock returns) but adds M/B_{t-2} to the regression to address the possibility that lagged Q might enter the regression (we instrument for both M/B_{t-1} and M/B_{t-2}). Model 4 drops the most recent three 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 M/B (the first-stage regression includes CF_t, CF_{t-1}, and lags 4 and 5 of returns). All four tests confirm that cashflow remains significant after controlling for measurement error in M/B. Investment-cashflow sensitivities in Model 3 are very similar to those reported in Section 5, while investment-cashflow sensitivities in Models 1, 2, and 4 are substantially higher.

The conclusions from Table A1 also carry over to the constrained and unconstrained subsamples: cashflow effects in our four robustness checks are large, significant, and often greater than those reported in Section 5 (and never significantly lower). Details are available on request.

Table A1
Robustness checks: IV regressions, 1972–2009

This table reports average slopes, R^2s, and sample sizes from annual cross-sectional regressions. M/B* is the fitted value when M/B is regressed on various lags of cashflow and stock returns (instruments for Q): Model 1 uses CF_t, CF_{t-1}, …, 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 four lags of stock returns as instruments (for both M/B_{t-1} and M/B_{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 correction with three 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							
	dCash	dNWC	Capx1	Capx2	Capx3	dDebt2	Issues	Div
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
M/B_{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
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
M/B_{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
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
M/B_{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
M/B_{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
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
M/B_{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

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