

The Cash Flow Sensitivity of Cash

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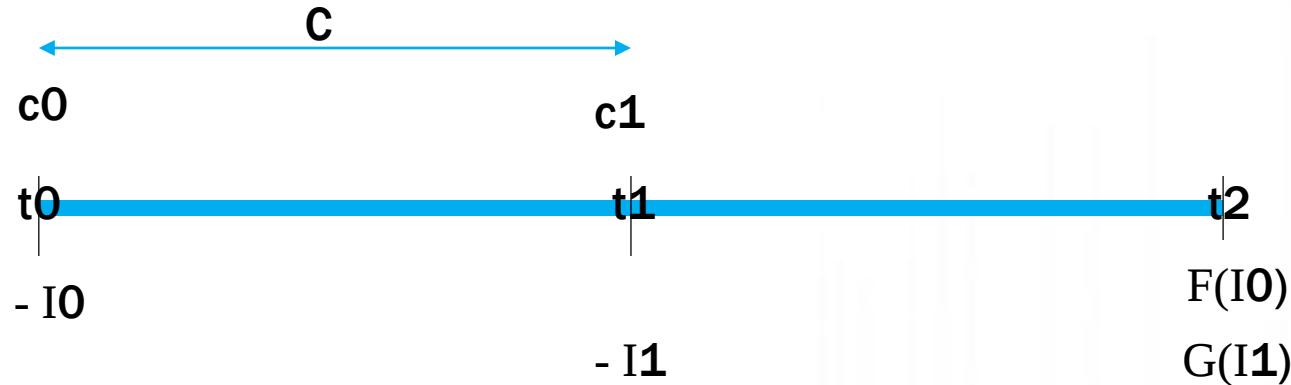
Overview on “The Cash Flow Sensitivity of Cash”

- This paper examines the effect of financial constraints on **the firm’s propensity to save cash out of cash flows** (the cash flow sensitivity of cash)
- **Hypothesis:** Constrained firms should have a positive cash flow sensitivity of cash, while unconstrained firms’ cash savings should not be systematically related to cash flows.
- The sampled firms include only manufacturers (SICs 2000 to 3999) in the COMPUSTAT annual industrial tapes. The sample period is 1971 through 2000. Data was collected on **“Firm-year” basis**.



Model of Liquidity Demand

Part A: Structure



- “ c_0 ” is the cash flow from current operations
- “ c_1 ” is the cash flow from time1 operations
- “ C ” is the amount of cash the firm chooses to carry from time 0 until time 1.
- Firm invests I_0 at time 0, the technology produces $F(I_0)$ at time 2.
- Firm invests I_1 at time 1, the technology produces $G(I_1)$ at time 2.

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Part B: Analysis

The firm's objective is to maximize the expected lifetime sum of all dividends subject to various budget and financial constraints.

$$\max_{C, h, I} (d_0 + p d_1^H + (1 - p) d_1^L + p d_2^H + (1 - p) d_2^L) \text{ s.t.} \quad (1)$$

$$d_0 = c_0 + B_0 - I_0 - C \geq 0$$

$$d_1^S = c_1^S + h^S + B_1^S - I_1^S + C \geq 0 \quad \text{for } S = H, L$$

$$d_2^S = f(I_0) + g(I_1^S) - B_0 - B_1^S \quad \text{for } S = H, L$$

$$B_0 \leq (1 - \tau) q I_0$$

$$B_1^S \leq (1 - \tau) q I_1^S, \text{ for } S = H, L$$

$$p h^H + (1 - p) h^L = 0.$$

Note that our framework considers four components of financial policy: cash management, hedging, dividend payouts, and borrowing. (B_0, B_1^S, C, h^H)

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Part B: Analysis

B.1 First-Best Solution

- The firm is financially unconstrained if it is able to invest at the first-best levels at times 0 and 1 that is

$$f'(I_0^{FB}) = 1$$

$$g'(I_1^{FB,S}) = 1 \quad \text{for } S = H, L.$$

- The condition for the firm to be unconstrained is that there exists a financial policy (B_0, B_1^S, C, h^H) such that

$$I_0^{FB} \leq c_0 + B_0 - C$$

$$I_1^{FB} \leq c_1^H - \frac{1-p}{p}h^L + B_1^H + C$$

$$I_1^{FB} \leq c_1^L + h^L + B_1^L + C,$$

- Its financial policy can be replaced by an entirely different financial policy $(\hat{B}_{0j}, \hat{B}_{1j}, \hat{C}_j, \hat{h}_j^H)$ with no implications for firm value.

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Part B: Analysis

B.2 Constrained Solution

$$\max_{C, h^L} f\left(\frac{c_0 - C}{1 - q + \tau q}\right) + pg\left(\frac{c_1^H - \frac{1-p}{p}h^L + C}{1 - q + \tau q}\right) + (1 - p)g\left(\frac{c_1^L + h^L + C}{1 - q + \tau q}\right). \quad (3)$$

To economize on notation, define $\lambda \equiv 1 - q + \tau q$.

Financial constraints lead to an optimal cash policy C^* , which is determined by the following first order condition (w.r.t. C)

$$f'\left(\frac{c_0 - C^*}{\lambda}\right) = g'\left(\frac{E_0[c_1] + C^*}{\lambda}\right). \quad (4)$$

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Part B: Analysis

B.2 Constrained Solution

- Sensitivity analysis

$$\frac{\partial C^*}{\partial c_0} = \frac{f''(I_0^*)}{f''(I_0^*) + g''(I_1^*)}. \quad (5) \rightarrow \text{“The Cash Flow Sensitivity of Cash”}$$

- Let define the concave production function as

$$F(x) = A \ln(x) \quad \text{and} \quad G(y) = B \ln(y). \quad (6)$$

- Derive an explicit formula for C^* as a function of c_0

$$C^* = \frac{\delta c_0 - E_0[c_1]}{1 + \delta}, \quad (7)$$

- The cash flow sensitivity of cash is given by $\delta / 1 + \delta$ where δ can be interpreted as a measure of the importance of future growth opportunities vis-a-vis current opportunities.

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Part C: Implications

PROPOSITION: The cash flow sensitivity of cash, $\frac{\partial C}{\partial c_0}$, has the following properties:

(i) $\frac{\partial C}{\partial c_0}$ is positive for financially constrained firms,

➤ Constrained firms should have a positive and significant cash flow sensitivity of cash

(ii) $\frac{\partial C}{\partial c_0}$ indeterminate for financially unconstrained firms.

➤ Unconstrained firms' cash savings should not be systematically related to cash flows.

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Empirical Tests

Part A: Measuring the Cash Flow Sensitivity of Cash and Financial Constraints

A.1 Empirical Models of Cash Flow Retention : Baseline Model

Hypothesis #1 : Constrained firms should have a positive cash flow sensitivity of cash

- α_1 in constrained firms' model should be positive and statistically significant

Hypothesis #2: Unconstrained firms' cash savings should not be systematically related to cash flows.

- α_1 in unconstrained firms' model should be statistically insignificant

$$\Delta CashHoldings_{i,t} = \alpha_0 + \alpha_1 CashFlow_{i,t} + \alpha_2 Q_{i,t} + \alpha_3 Size_{i,t} + \varepsilon_{i,t}, \quad (8)$$

The Cash Flow Sensitivity of Cash : $\frac{\partial C}{\partial c_0}$

CashHoldings = the ratio of holdings of cash and marketable securities to total assets

CashFlow = the ratio of earnings before extraordinary items and depreciation (minus dividends) to total assets

Q = the market value divided by the book value of assets. (Investment opportunity)

Size = the natural log of assets

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Part A: Measuring the Cash Flow Sensitivity of Cash and Financial Constraints

A.1 Empirical Models of Cash Flow Retention : Augmented model

In addition to Hypothesis #1 and #2 : We expect a larger estimate for α_1 from the augmented equation (9) relative to that from equation (8) if cash flows indeed drive cash savings.

$$\Delta CashHoldings_{i,t} = \alpha_0 + \alpha_1 CashFlow_{i,t} + \alpha_2 Q_{i,t} + \alpha_3 Size_{i,t} + \alpha_4 Expenditures_{i,t} + \alpha_5 Acquisitions_{i,t} + \alpha_6 \Delta NWC_{i,t} + \alpha_7 \Delta ShortDebt_{i,t} + \varepsilon_{i,t}. \quad (9)$$

The Cash Flow Sensitivity of Cash: $\frac{\partial C}{\partial c_0}$

CashHoldings = the ratio of holdings of cash and marketable securities to total assets

CashFlow = the ratio of earnings before extraordinary items and depreciation (minus dividends) to total assets

Q = the market value divided by the book value of assets.

Size = the natural log of assets , Expenditures = capital expenditures , Acquisitions = acquisitions

NWC = changes in noncash net working capital , ShortDebt = changes in short-term debt

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Part A: Measuring the Cash Flow Sensitivity of Cash and Financial Constraints

A.2 Financial Constraints Criteria

Criteria	Meaning	Classification	
		Financially Constrained Firm	Financially Unconstrained Firm
Payout Ratio	Ratio of dividends plus stock repurchases to operating income	Firms in the bottom three deciles of the annual payout distribution.	Firms in the top three deciles of the annual payout distribution.
Firm Size	Asset size	Firms in the bottom three deciles of the size distribution.	Firms in the top three deciles of the size distribution.
Bond Ratings	Firms' bond ratings	Firms that never had their public debt rated during our sample period and report positive debt	Firms that bonds have been rated during the sample period
Commercial Papers Ratings	Firms' commercial paper ratings	Firms that commercial paper have never been rated during the sample period and report positive debt	Firms that issued commercial papers receiving ratings at some point during the sample period
KZ Index	Financial constraints index based on Kaplan and Zingales (1997)	Firms in the top three deciles of the KZ index ranking	Firms in the bottom three deciles of the KZ index ranking

$$KZindex = -1.002 \times CashFlow + 0.283 \times Q + 3.139 \times Leverage$$

$$-39.368 \times Dividends - 1.315 \times CashHoldings. \quad (10)$$

Table I
Cross-classification of Constraint Types

This table displays firm-year cross-classification for the various criteria used to categorize firm-years as either financially constrained or unconstrained. To facilitate visualization, we assign the letter (A) for constrained firms and (B) for unconstrained firms in each row/column. The sampled firms include only manufacturers (SICs 2000 to 3999) in the COMPUSTAT annual industrial tapes. The sample period is 1971 through 2000.

Financial Constraints Criteria	Payout Ratio		Firm Size		Bond Ratings		CP Ratings		KZ Index	
	(A)	(B)	(A)	(B)	(A)	(B)	(A)	(B)	(A)	(B)
1. Payout ratio										
Constrained firms (A)	9,010									
Unconstrained firms (B)		8,821								
2. Firm size										
Constrained firms (A)	4,010	1,753	9,002							
Unconstrained firms (B)	1,599	3,752		9,272						
3. Bond ratings										
Constrained firms (A)	5,393	3,930	7,759	1,712	15,805					
Unconstrained firms (B)	3,617	4,891	1,243	7,560		14,149				
4. Comm. paper ratings										
Constrained firms (A)	7,751	5,453	8,789	3,457	15,474	6,457	21,931			
Unconstrained firms (B)	1,259	3,368	213	5,815	331	7,692		8,023		
5. Kaplan–Zingales index										
Constrained firms (A)	3,540	1,559	1,463	2,666	3,126	4,295	5,625	1,796	7,421	
Unconstrained firms (B)	992	3,064	2,578	1,817	4,502	2,706	5,144	2,064		7,208

- Positive association among the sample splits generated by the first four measures of financial constraints.
- KZ index provides marked different direction of sample splits compared to other four measures. (The sample split generated by KZ index is not consistent with other four measures)

Table II
Summary Statistics of Cash Holdings

This table displays summary statistics for cash holdings across groups of financially constrained and unconstrained firms. We assign the letter (A) for constrained firms and (B) for unconstrained firms in each row. All data are from the annual COMPUSTAT industrial tapes. The sampled firms include only manufacturers (SICs 2000 to 3999) and the sample period is 1971 through 2000.

Cash Holdings	Mean	Median	Std. Dev.	N. Obs
Financial Constraints Criteria				
1. Payout ratio				
Constrained firms (A)	0.145	0.074	0.177	9,010
Unconstrained firms (B)	0.090	0.051	0.106	8,821
<i>p</i> -value ($A - B \neq 0$)	0.00	0.00		
2. Firm size				
Constrained firms (A)	0.178	0.110	0.191	9,002
Unconstrained firms (B)	0.079	0.051	0.082	9,272
<i>p</i> -value ($A - B \neq 0$)	0.00	0.00		
3. Bond ratings				
Constrained firms (A)	0.146	0.085	0.167	15,805
Unconstrained firms (B)	0.081	0.049	0.092	14,149
<i>p</i> -value ($A - B \neq 0$)	0.00	0.00		
4. Comm. paper ratings				
Constrained firms (A)	0.129	0.070	0.155	21,931
Unconstrained firms (B)	0.076	0.051	0.076	8,023
<i>p</i> -value ($A - B \neq 0$)	0.00	0.00		
5. Kaplan–Zingales index				
Constrained firms (A)	0.055	0.030	0.076	7,421
Unconstrained firms (B)	0.179	0.134	0.166	7,208
<i>p</i> -value ($A - B \neq 0$)	0.00	0.00		

- According to the payout ratio, size, and the two ratings criteria, unconstrained firms hold on average 8–9% of their total assets in the form of cash and marketable securities.
- Constrained firms, on the other hand, hold far more cash in their balance sheets; on average, some 15% of total assets
- KZ index yields substantially different from the others, it classifies firms that hold more cash as unconstrained.
- Mean and median tests reject equality in the level of cash holdings across groups in all cases.

Empirical Tests

Part B: Results

Table III : The Baseline Regression Model

- A total of 10 estimated equations is reported (five constraints criteria × two constraints categories)

$$\Delta CashHoldings_{i,t} = \alpha_0 + \alpha_1 CashFlow_{i,t} + \alpha_2 Q_{i,t} + \alpha_3 Size_{i,t} + \varepsilon_{i,t}, \quad (8)$$

Table IV : The Augmented Regression Model

- A total of 10 estimated equations is reported (five constraints criteria × two constraints categories)

$$\begin{aligned} \Delta CashHoldings_{i,t} = & \alpha_0 + \alpha_1 CashFlow_{i,t} + \alpha_2 Q_{i,t} + \alpha_3 Size_{i,t} \\ & + \alpha_4 Expenditures_{i,t} + \alpha_5 Acquisitions_{i,t} \\ & + \alpha_6 \Delta NWC_{i,t} + \alpha_7 \Delta ShortDebt_{i,t} + \varepsilon_{i,t}. \end{aligned} \quad (9)$$

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Table III
The Baseline Regression Model

This table displays results for OLS estimations of the baseline regression model (equation (8)). All data are from the annual COMPUSTAT industrial tapes. The sampled firms include only manufacturers (SICs 2000 to 3999) and the sample period is 1971 through 2000. The estimations include firm effects and correct the error structure for heteroskedasticity and for within-period error correlation using the White–Huber estimator. The associated *t*-statistics are reported in parentheses.

Dependent Variable	Independent Variables			
<i>ΔCashHoldings</i>	<i>CashFlow</i>	<i>Q</i>	<i>Size</i>	<i>R</i> ²
Financial Constraints Criteria				
1. Payout ratio				
Constrained firms	0.0593 (4.53)*	0.0029 (2.41)**	0.0019 (0.61)	0.28
Unconstrained firms	−0.0074 (−0.28)	0.0001 (0.01)	0.0001 (0.05)	0.28
2. Firm size				
Constrained firms	0.0620 (4.12)*	0.0016 (1.65)	−0.0014 (−0.28)	0.26
Unconstrained firms	0.0099 (0.47)	0.0015 (1.52)	−0.0035 (−1.55)	0.17
3. Bond ratings				
Constrained firms	0.0580 (4.80)*	0.0016 (2.31)**	−0.0029 (−1.07)	0.20
Unconstrained firms	0.0179 (1.35)	0.0025 (1.91)	−0.0022 (−0.92)	0.15
4. Comm. paper ratings				
Constrained firms	0.0505 (4.83)*	0.0017 (2.93)*	−0.0031 (−1.37)	0.17
Unconstrained firms	0.0108 (0.49)	0.0022 (1.78)	−0.0014 (−0.46)	0.12
5. Kaplan–Zingales index				
Constrained firms	0.0045 (0.26)	0.0061 (4.43)*	0.0015 (0.71)	0.33
Unconstrained firms	0.1066 (3.01)*	0.0003 (0.26)	−0.0026 (−0.61)	0.22

* and ** indicate statistical significance at the 1% and 5% (two-tail) test levels, respectively.

Hypothesis #1 : Constrained firms should have a positive cash flow sensitivity of cash (α_1 should be positive and statistically significant)

➤ **Results:** Sensitivity estimates (α_1) vary between 0.051 and 0.062 and are all statistically significant at better than the 1% level (excluding the KZ index).

Hypothesis #2: Unconstrained firms' cash savings should not be systematically related to cash flows (α_1 should be statistically insignificant)

➤ **Results:** Insignificant cash–cash flow sensitivities(α_1)

Table IV
The Augmented Regression Model

This table displays results for IV estimations of the augmented regression model (equation (9)). All data are from the annual COMPUSTAT industrial tapes. The sampled firms include only manufacturers (SICs 2000 to 3999) and the sample period is 1971 through 2000. The estimations include firm effects and correct the error structure for heteroskedasticity and for within-period error correlation using the White-Huber estimator. The associated *t*-statistics are reported in parentheses.

Dependent Variable <i>ΔCashHoldings</i>	Independent Variables							<i>R</i> ²
	<i>CashFlow</i>	<i>Q</i>	<i>Size</i>	<i>Expenditures</i>	<i>Acquisitions</i>	<i>ΔNWC</i>	<i>ΔShortDebt</i>	
Financial Constraints Criteria								
1. Payout ratio								
Constrained firms	0.1488 (1.86)	0.0103 (1.65)	0.0123 (1.11)	−0.6471 (−0.92)	−0.5061 (−0.53)	−0.0013 (−4.35)*	0.1196 (1.05)	0.11
Unconstrained firms	0.0240 (0.44)	−0.0015 (−0.39)	0.0608 (2.75)*	−1.6137 (−1.89)	−3.1656 (−2.72)*	−0.0004 (−1.92)	0.5432 (2.39)**	0.07
2. Firm size								
Constrained firms	0.3836 (12.24)*	0.0118 (5.22)*	0.0539 (5.05)*	−1.2773 (−4.78)*	−0.1763 (−0.70)	−0.0223 (−14.27)*	0.3735 (4.78)*	0.15
Unconstrained firms	0.0364 (1.08)	0.0010 (0.62)	0.0179 (3.12)*	0.0626 (0.25)	−0.7855 (−2.74)*	−0.0001 (−2.82)*	0.2435 (2.32)**	0.12
3. Bond ratings								
Constrained firms	0.2793 (3.17)*	0.0073 (1.23)	0.0291 (1.26)	−1.1936 (−1.63)	0.1016 (0.13)	−0.0051 (−4.41)*	0.2735 (1.58)	0.11
Unconstrained firms	−0.0975 (−1.81)	0.0109 (3.31)*	0.0358 (3.92)*	−0.2179 (−0.64)	−2.4192 (−3.68)*	−0.0001 (−0.63)	0.1575 (1.41)	0.13
4. Comm. paper ratings								
Constrained firms	0.3374 (5.13)*	0.0127 (3.51)*	0.0265 (2.16)**	−1.6352 (−3.17)*	−0.2931 (−0.53)	−0.0049 (−6.11)*	0.2443 (2.42)**	0.12
Unconstrained firms	−0.2777 (−2.13)**	0.0050 (1.93)	0.0330 (3.06)*	0.6430 (2.08)**	−1.6936 (−2.43)**	0.0001 (0.49)	0.0093 (0.09)	0.12
5. Kaplan–Zingales index								
Constrained firms	0.1621 (1.97)**	0.0080 (1.60)	−0.0097 (−0.88)	−0.9989 (−2.52)**	0.0552 (0.13)	−0.0003 (−3.02)*	0.2937 (2.28)**	0.10
Unconstrained firms	0.3053 (3.40)*	0.0216 (2.27)**	0.0398 (1.32)	−2.1115 (−1.33)	0.2851 (0.28)	−0.0053 (−4.31)*	0.7159 (2.29)**	0.09

* and ** indicate statistical significance at the 1% and 5% (two-tail) test levels, respectively.

Table IV
The Augmented Regression Model

This table displays results for IV estimations of the augmented regression model (equation (9)). All data are from the annual COMPUSTAT industrial tapes. The sampled firms include only manufacturers (SICs 2000 to 3999) and the sample period is 1971 through 2000. The estimations include firm effects and correct the error structure for heteroskedasticity and for within-period error correlation using the White-Huber estimator. The associated *t*-statistics are reported in parentheses.

Dependent Variable <i>ΔCashHoldings</i>	Independent Variables							<i>R</i> ²
	<i>CashFlow</i>	<i>Q</i>	<i>Size</i>	<i>Expenditures</i>	<i>Acquisitions</i>	<i>ΔNWC</i>	<i>ΔShortDebt</i>	
Financial Constraints Criteria								
1. Payout ratio								
Constrained firms	0.1488 (1.86)	0.0103 (1.65)	0.0123 (1.11)	−0.6471 (−0.92)	−0.5061 (−0.53)	−0.0013 (−4.35)*	0.1196 (1.05)	0.11
Unconstrained firms	0.0240 (0.44)	−0.0015 (−0.39)	0.0608 (2.75)*	−1.6137 (−1.89)	−3.1656 (−2.72)*	−0.0004 (−1.92)	0.5432 (2.39)**	0.07
2. Firm size								
Constrained firms	0.3836 (12.24)*	0.0118 (5.22)*	0.0539 (5.05)*	−1.2773 (−4.78)*	−0.1763 (−0.70)	−0.0223 (−14.27)*	0.3735 (4.78)*	0.15
Unconstrained firms	0.0364 (1.08)	0.0010 (0.62)					2435 (32)**	0.12
3. Bond ratings								
Constrained firms	0.2793 (3.17)*	0.0073 (1.23)					2735 (58)	0.11
Unconstrained firms	−0.0975 (−1.81)	0.0109 (3.31)*					1575 (41)	0.13
4. Comm. paper ratings								
Constrained firms	0.3374 (5.13)*	0.0127 (3.51)*	0.0265 (2.16)**	−1.6352 (−3.17)*	−0.2931 (−0.53)	−0.0049 (−6.11)*	0.2443 (2.42)**	0.12
Unconstrained firms	−0.2777 (−2.13)**	0.0050 (1.93)	0.0330 (3.06)*	0.6430 (2.08)**	−1.6936 (−2.43)**	0.0001 (0.49)	0.0093 (0.09)	0.12
5. Kaplan–Zingales index								
Constrained firms	0.1621 (1.97)**	0.0080 (1.60)	−0.0097 (−0.88)	−0.9989 (−2.52)**	0.0552 (0.13)	−0.0003 (−3.02)*	0.2937 (2.28)**	0.10
Unconstrained firms	0.3053 (3.40)*	0.0216 (2.27)**	0.0398 (1.32)	−2.1115 (−1.33)	0.2851 (0.28)	−0.0053 (−4.31)*	0.7159 (2.29)**	0.09

Results for Hypothesis #1 and #2 : The sensitivity estimates (α1) are all positive and mostly highly significant for constrained firms but insignificant for the unconstrained ones, with the usual exception of the KZ index regressions.

Results for Hypothesis #1 and #2 : The sensitivity estimates (α_1) are all positive and mostly highly significant for constrained firms but insignificant for the unconstrained ones, with the usual exception of the KZ index regressions.

* and ** indicate statistical significance at the 1% and 5% (two-tail) test levels, respectively.

Table III Baseline model

Dependent Variable	
$\Delta CashHoldings$	<i>CashFlow</i>
Financial Constraints Criteria	
1. Payout ratio	
Constrained firms	0.0593 (4.53)*
Unconstrained firms	-0.0074 (-0.28)
2. Firm size	
Constrained firms	0.0620 (4.12)*
Unconstrained firms	0.0099 (0.47)
3. Bond ratings	
Constrained firms	0.0580 (4.80)*
Unconstrained firms	0.0179 (1.35)
4. Comm. paper ratings	
Constrained firms	0.0505 (4.83)*
Unconstrained firms	0.0108 (0.49)
5. Kaplan-Zingales index	
Constrained firms	0.0045 (0.26)
Unconstrained firms	0.1066 (3.01)*

Table IV Augmented model

Dependent Variable	
$\Delta CashHoldings$	<i>CashFlow</i>
Financial Constraints Criteria	
1. Payout ratio	
Constrained firms	0.1488 (1.86)
Unconstrained firms	0.0240 (0.44)
2. Firm size	
Constrained firms	0.3836 (12.24)*
Unconstrained firms	0.0364 (1.08)
3. Bond ratings	
Constrained firms	0.2793 (3.17)*
Unconstrained firms	-0.0975 (-1.81)
4. Comm. paper ratings	
Constrained firms	0.3374 (5.13)*
Unconstrained firms	-0.2777 (-2.13)**
5. Kaplan-Zingales index	
Constrained firms	0.1621 (1.97)**
Unconstrained firms	0.3053 (3.40)*

In addition to Hypothesis #1 and #2 :
We expect a larger estimate for α_1 from the augmented equation (9) relative to that from equation (8)

➤ **Results:** The median estimate of the constrained firms' sensitivity is nearly five times larger than the corresponding estimate from Table III.

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Part C: Robustness

#1 : Sample restricted to firms with positive free cash flow

- Using sample of firm-years for which cash flows are strictly larger than required investment outlays

#2 : Q is replaced by the ratio of (realized) future investment to current investment

- Replacing Q with the actual ratio of future investment to current investment

#3 : Q is instrumented with financial analysts' earnings forecasts

- Replacing Q with financial analysts' forecasts of earnings

#4 : Lagged Cash/Assets and its interaction with CashFlow are added to the r.h.s. of the model

- Adding to the baseline model the twice-lagged level of firm cash holdings, as well as its interaction with the cash flow variable.



Table V
Robustness Checks

This table shows results for alternative versions of the baseline model (equation (8)) and alternative sampling. Only the coefficients returned for *CashFlow* are reported. All data are from the annual COMPUSTAT industrial tapes. The sampled firms include only manufacturers (SICs 2000 to 3999) from 1971 through 2000. The estimations include firm effects and correct the error structure for heteroskedasticity and for within-period error correlation using the White-Huber estimator. The associated *t*-statistics are reported in parentheses.

Dependent Variable $\Delta \text{CashHoldings}$	Financial Constraints Criteria				
	Payout Ratio	Firm Size	Bond Ratings	CP Ratings	KZ Index
1. Sample restricted to firms with positive free cash flow					
Constrained firms	0.0789 (1.89)	0.0889 (2.40)**	0.0954 (3.58)*	0.0966 (4.39)*	0.0157 (0.43)
Unconstrained firms	-0.1052 (-2.32)**	0.0520 (1.05)	0.0657 (1.18)	0.0062 (0.11)	0.1815 (2.89)*
2. <i>Q</i> is replaced by the ratio of (realized) future investment to current investment					
Constrained firms	0.0450 (2.35)**	0.0729 (3.17)*	0.0614 (3.22)*	0.0498 (3.57)*	0.0020 (0.09)
Unconstrained firms	0.0068 (0.22)	0.0090 (0.58)	0.0120 (0.86)	0.0044 (0.27)	0.1118 (2.70)*
3. <i>Q</i> is instrumented with financial analysts' earnings forecasts					
Constrained firms	0.0447 (3.50)*	0.0144 (0.71)	0.0568 (2.76)*	0.0867 (2.06)**	0.0496 (1.30)
Unconstrained firms	-0.0091 (-0.68)	0.0181 (0.98)	0.0255 (1.06)	0.0119 (0.72)	0.0950 (4.94)*
4. Lagged <i>Cash / Assets</i> and its interaction with <i>CashFlow</i> are added to the r.h.s. of the model					
Constrained firms	0.0621 (2.63)*	0.1243 (3.80)*	0.0431 (1.98)**	0.0415 (2.96)*	0.0021 (0.07)
Unconstrained firms	-0.0127 (-0.40)	0.0178 (1.01)	0.0204 (1.26)	-0.0209 (-0.88)	0.0597 (2.26)**

* and ** indicate statistical significance at the 1% and 5% (two-tail) test levels, respectively.

Result for all robustness checks:
Still find the same patterns that is only constrained firms display significant cash-cash flow sensitivities , except when using the KZ index.

Empirical Tests

Part D: Dynamics of Liquidity Management: Response to Macroeconomic Shocks

Question : How do cash policies change in response to events affecting both the firm's ability to generate cash flows as well as the shadow cost of new investment?

Expected Results : Financially constrained firms saving an even greater proportion of their cash flows during downturns, while the cash policy of financially unconstrained firms will not display such pronounced patterns.

In other words, **the responses of cash flow sensitivities of cash to shocks to aggregate demand should be stronger (i.e., more countercyclical) for financially constrained firms.**

$$\Psi_t = \eta + \phi \Delta Activity_t + \rho Trend_t + u_t, \quad (11)$$

The Cash Flow Sensitivity of Cash

The residual of an autoregression of log real GDP on Three of its own lag

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Table VI
Macroeconomic Dynamics

The dependent variable is the estimated sensitivity of cash holdings to cash flow. In each estimation, the dependent variable is regressed on the residual of an autoregression of the log real GDP on three of its own lags ($\Delta Activity$). All regressions include a constant and a time trend. Only the coefficients returned for $\Delta Activity$ are reported in the table. In the multivariate regressions, changes in inflation (log CPI) and changes in basic interest rates (Fed funds rate) are also added. The sampled firms include only manufacturers (SICs 2000 to 3999) and the sample period is 1971 through 2000. Heteroskedasticity- and autocorrelation-consistent errors are computed with a Newey–West lag window of size four. The standard errors for cross-equation differences in the GDP-innovation coefficients are computed via a SUR system that estimates the group regressions jointly. The associated p -values are reported in parentheses.

	Financial Constraints Criteria				
	Payout Ratio	Firm Size	Bond Ratings	CP Ratings	KZ Index
1. Constrained firms					
Univariate	−1.841 (0.01)	−1.576 (0.08)	−1.898 (0.00)	−1.333 (0.00)	0.156 (0.31)
Multivariate	−2.233 (0.02)	−2.283 (0.08)	−2.268 (0.01)	−1.491 (0.01)	−0.255 (0.70)
2. Unconstrained firms					
Univariate	1.867 (0.31)	1.509 (0.03)	0.212 (0.81)	0.345 (0.74)	−3.547 (0.00)
Multivariate	1.769 (0.25)	1.675 (0.01)	0.426 (0.67)	0.292 (0.82)	−3.876 (0.00)
3. Difference constrained–unconstrained					
Univariate	−3.708 (0.05)	−3.086 (0.02)	−2.110 (0.02)	−1.678 (0.10)	3.703 (0.01)
Multivariate	−4.002 (0.03)	−3.958 (0.00)	−2.693 (0.01)	−1.783 (0.12)	3.621 (0.02)

➤ Constrained firms' cash policies respond to shocks to aggregate demand

➤ Unconstrained firms' cash policies do not respond to shocks to aggregate demand

➤ Constrained firms save significantly larger fractions of their cash flows than unconstrained firms do following those shocks.

Concluding Remarks

- For the first four classification schemes, we find that constrained firms display significantly positive cash—cash flow sensitivities, while unconstrained firms do not. **Our empirical results are consistent with our theory.**
- **The exact opposite results obtain for the KZ index**, which, as we document, generates constrained/unconstrained firm assignments that correlate mostly negatively with those of the other four classification criteria.
- Our theory also suggests that **cash holding patterns should vary over the business cycle**. In particular, financially constrained firms will increase their propensity to retain cash following negative macroeconomic shocks, while unconstrained firms do not.
- We examine this hypothesis empirically and find that **it holds for four of our classification criteria, but again not for the KZ index.**



Q & A

