The Effects of Capital Investment and R&D Expenditures on Firms' Liquidity

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- Introduction
- Literature review
- Empirical implementation
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Motivation and focus of the research

- Nonfinancial corporations in major developed economies hold considerable cash on their balance sheets, in excess of transactions needs
- Sizable cash holdings may reflect firms' precautionary demand for liquidity in the presence of market imperfections
- Planned spending on capital goods may induce firms to build up cash balances
- Planned R&D expenditures may also cause firms to accumulate cash
- These factors may have important interactions in determining cash accumulation and decumulation

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- Researchers have recognized the importance of current and future investment for liquidity management, but with no consensus on how to capture these effects
- Both current investment expenditures and Tobin's Q have limitations in this regard
- We avoid these limitations by considering the effects of one-period-ahead capital spending and R&D spending on firms' liquidity, under the assumption of rational expectations
- We scrutinize which type of investment—fixed capital or R&D spending—leads to higher accumulation of cash buffer stocks
- We expect to find that non-collateralizable R&D spending will place heavier demands on liquidity

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Preview of findings

- We investigate these issues for sizable panels of firms in the US, UK and Germany to evaluate the effects of different financial systems on liquidity management
- We categorize firms by two indicators: size and their dividend payout ratio to consider homogeneity of behavior
- We find that firms in all three economies adjust their liquidity by a greater proportion in response to future R&D spending than to planned fixed capital investment
- This behavior is particularly apparent in the case of small firms and non-dividend paying firms that are heavily involved in R&D activities
- The "cash flow sensitivity of cash" is higher for constrained firms than for their unconstrained counterparts in the US and UK, but only marginally higher for Germany

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Determinants of cash holdings

- Firms hold cash buffers due to transactions costs motive and precautionary motive
- Precautionary motive considers costs involved with missed investment opportunities as well as risk of financial embarrassment
- Most firms have imperfect access to external funds, especially in the current economic environment
- Even if funds are available, they may involve a significant premium or covenants
- This suggests that firms facing financial frictions will seek to use lower-cost internal funds to avoid resorting to external sources

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- The Fazzari et al. methodology has been applied to model firms' liquidity behavior
- Kim and Sherman (JFQA, 1998) find that US firms facing higher costs of external finance, having more volatile earnings and exhibiting lower ROA carry larger stocks of liquid assets
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- Attempts to measure the value placed by stockholders on corporate cash holdings try to resolve whether cash buffers represent constraints or agency costs
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- Almeida, Campello and Weisbach (JF, 2004) show that constrained US firms have a positive cash flow sensitivity of cash, while unconstrained firms' cash balances are not systematically related to cash flows
- Khurana, Martin and Pereira (JFQA, 2006) use data from several countries to show that the sensitivity of cash holdings to cash flows decreases with financial development
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- We also want to evaluate how different *types* of capital spending may affect liquidity behavior.
- Many firms have a significant stock of "R&D capital" which may be subject to adjustment costs similar to those of fixed capital
- As R&D assets are primarily human capital, sizable risks of loss are associated with shortfalls in the flow of expenditures
- Investment in intangible capital, such as R&D, may be associated with a considerably higher marginal cost of external financing
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Empirical implementation

- To quantify the effects of future investment on liquidity behavior, we use a variant of an empirical specification proposed by earlier researchers
- Our model differs as it includes two types of investment: fixed capital and R&D spending
- We include the *changes* in those types of investment as determinants of the change in cash holdings, in a partial adjustment context
- We control for cash flow and changes in short term debt and working capital
- All variables are scaled by beginning-of-period total assets

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The baseline model:

$$\begin{aligned}\Delta Cash_{it} &= \alpha_0 + \alpha_1 \Delta Cash_{i,t-1} + \alpha_2 CashFlow_{it} + \alpha_3 \Delta RD_{i,t+1} \\ &+ \alpha_4 \Delta FixInv_{i,t+1} + \alpha_5 \Delta ShortDebt_{it} + \alpha_6 \Delta NWC_{it} \\ &+ \mu_i + \tau_t + \epsilon_{it}\end{aligned}$$

where i indexes the firm, t the year, and firm and year-specific effects are denoted by μ and τ, respectively. ϵ is an idiosyncratic error term.

Although this specification allows us to consider differences between R&D and fixed investment's effects on corporate liquidity, it does not allow us to explore variations in the cash-investment sensitivity, nor the effects of cash flow, between financially constrained and unconstrained firms. We specify an extended model in which cash flow and future investment expenditures are interacted with a vector of size or dividend payout categories.

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$$\begin{aligned}\Delta Cash_{it} &= \alpha_0 + \alpha_1 \Delta Cash_{i,t-1} + [CashFlow_{it} \times TYPE_{it}]\,\eta + \\ &\quad [\Delta RD_{i,t+1} \times TYPE_{it}]\,\gamma_1 + [\Delta FixInv_{i,t+1} \times TYPE_{it}]\,\gamma_2 + \\ &\quad \alpha_5 \Delta ShortDebt_{it} + \alpha_6 \Delta NWC_{it} + \mu_i + \tau_t + \epsilon_{it}\end{aligned}$$

where $TYPE_{it}$ is a vector of either three size categories or two dividend groups. Size categories are defined by average book value of assets per year for each country. The top quartile of firms are large; the bottom quartile of firms are small; and the remaining firms are medium. The dividend groups are those who pay dividends and those who do not, reevaluated annually.

Data

- The data are an unbalanced panel of firms from S&P's Global COMPUSTAT for the US, UK and Germany, 1991–2006: a total of 32,000 firm-years.
- Firms undergoing substantial changes in their composition are excluded by screening on the growth rate of each firm's total assets and sales
- Firms with cash flow-to-assets lower than 50% for three years are dropped
- The US sample contains 2,006 firms and 17,813 firm-years
- The UK sample contains 505 firms and 3,202 firm-years
- The German sample contains 352 firms and 2,306 firm-years

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- The data are an unbalanced panel of firms from S&P's Global COMPUSTAT for the US, UK and Germany, 1991–2006: a total of 32,000 firm-years.
- Firms undergoing substantial changes in their composition are excluded by screening on the growth rate of each firm's total assets and sales
- Firms with cash flow-to-assets lower than 50% for three years are dropped
- The US sample contains 2,006 firms and 17,813 firm-years
- The UK sample contains 505 firms and 3,202 firm-years
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Descriptive measures

- Analysis of the descriptive statistics shows that there are considerable variations in liquidity ratios across countries. The highest average liquidity ratio (14%) is maintained by US companies, while the lowest (9%) is found for companies headquartered in Germany.
- Those US companies that are involved in R&D invest almost as much in R&D as in fixed capital
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Table: Descriptive statistics: All Firms, 1991–2006

Panel A: US				
Variable	μ	σ	Median	N
Cash	0.144	0.176	0.070	17,813
Cash Flow	0.067	0.127	0.089	17,813
R&D	0.048	0.077	0.019	17,813
Fixed Investment	0.052	0.041	0.042	17,813
Short Term Debt	0.024	0.054	0.000	17,813
Panel B: Germany				
Cash	0.086	0.101	0.049	2,306
Cash Flow	0.080	0.096	0.087	2,306
R&D	0.013	0.035	0.000	2,306
Fixed Investment	0.068	0.049	0.058	2,306
Short Term Debt	0.109	0.111	0.068	2,306
Panel C: UK				
Cash	0.113	0.134	0.071	3,202
Cash Flow	0.077	0.119	0.097	3,202
R&D	0.020	0.054	0.000	3,202
Fixed Investment	0.060	0.044	0.051	3,202
Short Term Debt	0.073	0.083	0.045	3,202

- We may also categorize firm-years by size and dividend categories for each country. A given firm may move among these categories from one year to the next.
- This is particularly important for dividend payout among US firms, where the fraction of firms paying dividends declined considerably during the sample period due to tax considerations and share buybacks.
- Half of the US firm-year observations are associated with zero dividend payout
- UK and German dividend policy is quite different: most of the small and medium companies in the UK and Germany are more likely to pay dividends than their US counterparts
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Table: Tabulation of Size and Dividend Payout Subsamples

	Small	Medium	Large	Total
Panel A: US				
No Dividends	2,883 (16%)	4,899 (28%)	1,141 (6%)	8,923 (50%)
Dividends	797 (5%)	4,455 (25%)	3,638 (20%)	8,890 (50%)
Total	3,680 (21%)	9,354 (52%)	4,779 (23%)	17,813 (100%)
Panel B: Germany				
No Dividends	78 (5%)	158 (10%)	53 (3%)	289 (18%)
Dividends	194 (12%)	654 (41%)	448 (28%)	1,296 (82%)
Total	272 (17%)	812 (51%)	501 (31%)	1,585 (100%)
Panel C: UK				
No Dividends	74 (3%)	55 (2%)	15 (1%)	144 (5%)
Dividends	536 (18%)	1,533 (52%)	741 (25%)	2,810 (95%)
Total	610 (21%)	1,588 (54%)	756 (26%)	2,954 (100%)

- Considering descriptive statistics by size categories, there are several notable differences among the key variables across the three countries
- Firms in each size category maintain quite different levels of liquidity in all countries
- Small firms hold more cash than do their large counterparts
- Mixed evidence is observed for the R&D expenditures-to-total assets ratio
- US and UK small companies have the highest level of R&D activity in comparison to their larger counterparts, while the opposite is observed for German firms
- Small US firms have the highest liquidity ratio and the lowest short-term debt ratio across all countries
- German firms have the highest short-term debt ratio, perhaps reflecting their reliance on bank finance.
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Table: Descriptive statistics: Size categories

Panel A: US						
	Small		Medium		Large	
Variable	μ	σ	μ	σ	μ	σ
Cash	0.205	0.216	0.149	0.176	0.088	0.113
Cash Flow	0.013	0.183	0.075	0.114	0.094	0.074
R&D	0.085	0.120	0.042	0.063	0.033	0.045
Fixed Investment	0.045	0.044	0.053	0.041	0.056	0.037
Short Term Debt	0.032	0.075	0.018	0.048	0.027	0.045
Panel B: Germany						
Cash	0.096	0.124	0.076	0.089	0.096	0.102
Cash Flow	0.055	0.142	0.081	0.088	0.097	0.056
R&D	0.010	0.043	0.008	0.026	0.025	0.040
Fixed Investment	0.067	0.060	0.067	0.048	0.071	0.040
Short Term Debt	0.126	0.132	0.116	0.118	0.083	0.076
Panel C: UK						
Cash	0.127	0.168	0.112	0.133	0.103	0.092
Cash Flow	0.044	0.158	0.085	0.113	0.091	0.075
R&D	0.030	0.080	0.019	0.047	0.014	0.026
Fixed Investment	0.057	0.047	0.064	0.046	0.056	0.032
Short Term Debt	0.084	0.104	0.071	0.077	0.067	0.068

- Considering descriptive statistics by dividend payout, we observe sizable differences in firms' cash holdings between dividend paying and non-dividend paying firms for the US and UK
- Dividend-paying firms in the US and UK hold significantly less cash on average than do their non-dividend paying counterparts, while the opposite is observed for German companies.
- For all three countries we also note that non-dividend paying firms have a higher R&D-to-asset ratio than their dividend-paying counterparts
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Table: Descriptive statistics: Dividend categories

Panel A: US				
	No Dividends		Dividends	
Variable	μ	σ	μ	σ
Cash	0.195	0.206	0.094	0.120
Cash Flow	0.034	0.155	0.100	0.076
R&D	0.072	0.096	0.025	0.038
Fixed Investment	0.049	0.043	0.055	0.037
Short Term Debt	0.023	0.063	0.024	0.044
Panel B: Germany				
Cash	0.071	0.096	0.091	0.096
Cash Flow	0.011	0.127	0.109	0.057
R&D	0.016	0.058	0.013	0.030
Fixed Investment	0.050	0.040	0.076	0.049
Short Term Debt	0.140	0.130	0.097	0.098
Panel C: UK				
Cash	0.202	0.241	0.104	0.113
Cash Flow	-0.094	0.196	0.097	0.086
R&D	0.093	0.145	0.013	0.027
Fixed Investment	0.038	0.036	0.062	0.044
Short Term Debt	0.091	0.122	0.069	0.073

Empirical findings

- We estimate our baseline and extended models with the two-step System GMM dynamic panel data (DPD) estimator of Blundell and Bond (J Metrics 1998)
- Due to the inclusion of future values of explanatory variables, we include only their third and higher lags in the instrument set
- All estimated models display appropriate Hansen J statistics for their overidentifying restrictions and suitable values for Arellano–Bond $AR(2)$ tests for second-order serial correlation

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Basic regression model

- We estimate the baseline model for each country from the unbalanced panel of firm-year observations
- We hypothesize that in explaining the change in cash balances, cash flow and both forms of future investment expenditure should have positive and significant coefficients
- We expect to find that future R&D expenditures have a larger effect on cash balances than do future fixed capital expenditures
- We expect that the impact of R&D expenditures would be most significant for US firms as they are more heavily engaged in R&D activities

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Table: Robust two-step GMM estimates of $\Delta Cash$

	US	Germany	UK
	(1)	(2)	(3)
ΔCash$_{t-1}$	-0.127***	-0.206**	-0.163***
	(0.048)	(0.085)	(0.059)
Cash Flow$_t$	0.208***	0.139*	0.197***
	(0.041)	(0.082)	(0.047)
ΔRD$_{t+1}$	0.920***	0.616**	0.545**
	(0.246)	(0.241)	(0.271)
ΔFix. Investment$_{t+1}$	0.182	-0.071	0.108
	(0.134)	(0.120)	(0.103)
ΔNWC$_t$	-0.338***	-0.030	-0.346***
	(0.080)	(0.047)	(0.093)
ΔShort Term Debt$_t$	-0.203*	0.018	-0.306***
	(0.121)	(0.095)	(0.090)
Firm-years	17,813	2,306	3,202
J pvalue	0.112	0.519	0.725
AR(2) pvalue	0.172	0.270	0.965
Test $\gamma_{\Delta RD} = \gamma_{\Delta FixInv}$, pvalue	0.009	0.013	0.073

Notes: Two-step GMM-SYS estimates of $\Delta Cash$ are reported. Time fixed effects are included in all specifications. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

- The change in future fixed investment expenditures is positive for the US and UK, negative for Germany, but insignificant for all countries
- The change in future R&D expenditures is positive and significant at the 1% level for US and at the 5% level for UK and German firms
- Firms accumulate more cash for future R&D expenditures than for future fixed investment expenditures, as captured by the relative magnitudes of their coefficients
- The tests of equality of $\gamma_{\Delta RD}$ and $\gamma_{\Delta FixInv}$ coefficients yields p-values of less than 0.10, unambiguously rejecting the null of equal coefficients

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- The coefficient of cash flow is positive for all countries and significant for both US and UK firms at the 1% level, and Germany at the 10% level
- The magnitudes of the point estimates imply that firms are likely to be more financially constrained in market based economies
- The coefficient on the lagged dependent variable for all countries is significant and negative, implying that firms have a target level of cash holdings and adjust their liquidity to achieve their target
- Changes in the non-cash net working capital ratio possess negative and significant coefficients for US and UK firms, while it is insignificant for the German firms
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Augmented regression model

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Firms' savings and the role of firm size

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- When interactions with investment are included as well, we find that future capital investment expenditures only affect US firms' saving

Firms' savings and the role of firm size

- When only cash flow interactions are included, small firms contribute to their savings more than their larger counterparts do as their cash flow increases
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- When we concentrate on the effects of future R&D expenditures, we see similar and sizable differences in saving behavior of firms for all countries
- Small firms' future R&D expenditures have a significant and larger impact on firms' savings compared to those of their larger or medium-size counterparts
- Constrained (small) firms tend to save more in comparison to unconstrained (large) firms, with future R&D expenditures emerging as an important factor that induces firms to adjust their cash holdings

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	US		Germany		UK	
ΔCash$_{t-1}$	-0.071*	-0.098**	-0.165**	-0.133**	-0.233***	-0.203***
	(0.043)	(0.042)	(0.065)	(0.059)	(0.059)	(0.076)
Small $\times$ CF$_t$	0.209***	0.191***	0.185*	0.202***	0.142***	0.185**
	(0.045)	(0.047)	(0.097)	(0.065)	(0.051)	(0.073)
Medium $\times$ CF$_t$	0.171***	0.152***	0.126**	0.183***	0.209***	0.249***
	(0.039)	(0.055)	(0.060)	(0.056)	(0.072)	(0.081)
Large $\times$ CF$_t$	0.076	0.027	0.080	0.136**	0.090	0.129
	(0.089)	(0.051)	(0.094)	(0.060)	(0.071)	(0.120)
ΔRD$_{t+1}$	0.464**		0.371*		0.412*	
	(0.185)		(0.200)		(0.219)	
ΔFix. Investment$_{t+1}$	0.359***		-0.069		-0.017	
	(0.130)		(0.103)		(0.102)	
ΔNWC$_t$	-0.289***	-0.302***	-0.037	-0.073	-0.316***	-0.349***
	(0.061)	(0.060)	(0.063)	(0.050)	(0.073)	(0.095)
ΔShort Term Debt$_t$	-0.167*	-0.227**	-0.001	0.024	-0.263***	-0.285***
	(0.092)	(0.091)	(0.084)	(0.068)	(0.072)	(0.110)
Small $\times$ ΔRD$_{t+1}$		0.510**		0.636*		0.889**
		(0.210)		(0.348)		(0.432)
Medium $\times$ ΔRD$_{t+1}$		0.338		0.080		0.019
		(0.275)		(0.188)		(0.837)
Large $\times$ ΔRD$_{t+1}$		0.676		-0.028		-0.239
		(0.493)		(0.199)		(0.448)
Small $\times$ ΔInv$_{t+1}$		0.346*		-0.003		0.252
		(0.180)		(0.113)		(0.201)
Medium $\times$ ΔInv$_{t+1}$		-0.125		0.178		0.223
		(0.158)		(0.111)		(0.198)
Large $\times$ ΔInv$_{t+1}$		0.221		0.075		-0.442
		(0.136)		(0.208)		(0.445)
Firm-years	17,813	17,813	2,306	2,306	3,202	3,202

Firms' savings and the role of dividend payments

- In all models, the coefficient of the lagged dependent variable is negative and significant, indicating that firms adjust their savings to achieve their optimal cash-to-asset ratio
- Non-dividend-paying US and UK firms increase their savings more than dividend-paying counterparts
- Dividend policy does not have an effect on German firms' liquidity behavior

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- There is no differential effect of future fixed investment expenditures on saving behavior across firms
- In the case of R&D expenditures, we see that US and UK firms that do not pay dividends augment their savings, while dividend-paying firms do not change their saving behavior in response to future R&D expenditures
- For Germany, we find no difference across the two groups
- This outcome could be explained by specific features of the German financial system, in which banks' monitoring and long-term customer relationships may reduce the need for dividends as signals of the firm's financial stability

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	US		Germany		UK	
	(1)	(2)	(3)	(4)	(5)	(6)
ΔCash$_{t-1}$	-0.096*	-0.108**	-0.112*	-0.153*	-0.175***	-0.125*
	(0.050)	(0.055)	(0.067)	(0.090)	(0.052)	(0.068)
No Div $\times$ CF$_t$	0.184***	0.250***	0.017	0.056	0.108	0.304*
	(0.042)	(0.045)	(0.107)	(0.124)	(0.101)	(0.182)
Div $\times$ CF$_t$	-0.008	-0.046	0.075	0.122	0.062	0.141
	(0.110)	(0.093)	(0.109)	(0.086)	(0.093)	(0.128)
ΔRD$_{t+1}$	0.489*		0.457*		0.614**	
	(0.259)		(0.248)		(0.294)	
ΔFix. Investment$_{t+1}$	0.085		-0.107		0.085	
	(0.140)		(0.118)		(0.148)	
ΔNWC$_t$	-0.401***	-0.437***	-0.038	-0.137*	-0.310**	-0.429**
	(0.092)	(0.100)	(0.068)	(0.081)	(0.124)	(0.215)
ΔShort Term Debt$_t$	-0.291**	-0.096	0.019	-0.120*	-0.271***	-0.366*
	(0.135)	(0.158)	(0.074)	(0.064)	(0.103)	(0.217)
No Div $\times$ ΔRD$_{t+1}$		0.741***		0.247		0.535***
		(0.271)		(0.427)		(0.179)
Div $\times$ ΔRD$_{t+1}$		-0.168		0.297		0.133
		(1.141)		(0.226)		(0.382)
No Div $\times$ ΔInv$_{t+1}$		0.241		-0.023		2.021*
		(0.179)		(0.247)		(1.224)
Div $\times$ ΔFInv$_{t+1}$		0.028		0.095		0.324*
		(0.388)		(0.126)		(0.177)
Firm-years	17,813	17,813	1,585	1,585	2,954	2,954

Conclusions

- Our findings highlight the importance of the impact of changes in future R&D investment on the optimal level of a firm's cash buffer
- R&D expenditures lead to accumulation of intangible capital which cannot be pledged as collateral
- Small and non-dividend paying firms substantially increase their cash holdings prior to increasing R&D expenditures
- This evidence is somewhat less relevant for German companies, operating in a bank-based financial environment
- In contrast to much of the literature that investigates cash holding behavior, we implement a dynamic framework to consider the potential impact of adjustment and transaction costs which may prevent firms from achieving their target cash holding levels instantaneously

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