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

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University of York, December 2009
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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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We expect to find that non-collateralizable R&D spending will place heavier demands on liquidity.
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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Preview of findings

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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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Review of the literature

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Seminal work of Fazzari, Hubbard, Petersen (BPEA, 1988) explains why cash flow of financially constrained firms affects capital spending. This literature has generally concluded that financial market frictions adversely affect capital investment expenditures of constrained firms relative to others. 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. Opler et al. (JFE, 1999) show that small firms and firms with strong growth opportunities and riskier cash flows hold more cash.
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Agency costs have also been used to explain firms’ excessive cash holdings, possibly resulting from empire-building managers.

Attempts to measure the value placed by stockholders on corporate cash holdings try to resolve whether cash buffers represent constraints or agency costs.

Shareholders should value cash buffers held for prudent motives more highly.

Faulkender and Wang (JF, 2006) and Pinkowitz and Williamson (RFS, 2001) find that the value of cash is higher in constrained firms.

Dittmar and Mahrt-Smith (JFE, 2007) and Harford, Manzi, Maxwell (JFE, 2008) find that cash has lower value for firms with weak shareholder rights.
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In contrast, several recent studies focus on firms’ cash accumulation behavior to investigate the effects of financial market frictions.

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.

Baum, Schäfer and Talavera (BC WP 690), using a panel of 36 countries, show that both financial development and countries’ financial systems affect the sensitivity of cash holdings to cash flows.
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Although cash holdings are surely related to investment opportunities, there is no consensus on how to measure these effects. Tobin’s $Q$ has traditionally been used, but Erickson and Whited (JPE, 2000) and Riddick and Whited (JF, 2009) have identified problems with this strategy. Use of current investment expenditures to proxy for investment opportunities (e.g., Opler et al. (JFE, 1999)) is also problematic. Our solution: employ realized future values of the level of capital investment, which under rational expectations is an unbiased forecast of future investment.
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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.
- R&D capital cannot generally be pledged as collateral, and exhibits more uncertain returns than physical capital.
- This implies that R&D spending may be more dependent on the availability of internal financing.
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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.
Empirical implementation

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The baseline model:

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\Delta \text{Cash}_{it} = \alpha_0 + \alpha_1 \Delta \text{Cash}_{i,t-1} + \alpha_2 \text{CashFlow}_{it} + \alpha_3 \Delta \text{RD}_{i,t+1} \\
+ \alpha_4 \Delta \text{FixInv}_{i,t+1} + \alpha_5 \Delta \text{ShortDebt}_{it} + \alpha_6 \Delta \text{NWC}_{it} \\
+ \mu_i + \tau_t + \epsilon_{it}
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where \(i\) indexes the firm, \(t\) the year, and firm and year-specific effects are denoted by \(\mu\) and \(\tau\), respectively. \(\epsilon\) 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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The extended model:

$$\Delta \text{Cash}_it = \alpha_0 + \alpha_1 \Delta \text{Cash}_{i,t-1} + [\text{CashFlow}_it \times \text{TYPE}_it] \eta + [\Delta \text{RD}_{i,t+1} \times \text{TYPE}_it] \gamma_1 + [\Delta \text{FixInv}_{i,t+1} \times \text{TYPE}_it] \gamma_2 + \alpha_5 \Delta \text{ShortDebt}_it + \alpha_6 \Delta \text{NWC}_it + \mu_i + \tau_t + \epsilon_{it}$$

where $\text{TYPE}_it$ 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.
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.
Empirical implementation

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The German sample contains 352 firms and 2,306 firm-years.
Empirical implementation

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.
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.
- UK firms have a smaller R&D to asset ratio and German firms have the smallest.
- German firms maintain the highest fixed investment rates and the highest short-term debt among the three countries.
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### Table: Descriptive statistics: All Firms, 1991–2006

<table>
<thead>
<tr>
<th>Panel A: US</th>
<th>Variable</th>
<th>$\mu$</th>
<th>$\sigma$</th>
<th>Median</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash</td>
<td>0.144</td>
<td>0.176</td>
<td>0.070</td>
<td>17,813</td>
<td></td>
</tr>
<tr>
<td>Cash Flow</td>
<td>0.067</td>
<td>0.127</td>
<td>0.089</td>
<td>17,813</td>
<td></td>
</tr>
<tr>
<td>R&amp;D</td>
<td>0.048</td>
<td>0.077</td>
<td>0.019</td>
<td>17,813</td>
<td></td>
</tr>
<tr>
<td>Fixed Investment</td>
<td>0.052</td>
<td>0.041</td>
<td>0.042</td>
<td>17,813</td>
<td></td>
</tr>
<tr>
<td>Short Term Debt</td>
<td>0.024</td>
<td>0.054</td>
<td>0.000</td>
<td>17,813</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B: Germany</th>
<th>Variable</th>
<th>$\mu$</th>
<th>$\sigma$</th>
<th>Median</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash</td>
<td>0.086</td>
<td>0.101</td>
<td>0.049</td>
<td>2,306</td>
<td></td>
</tr>
<tr>
<td>Cash Flow</td>
<td>0.080</td>
<td>0.096</td>
<td>0.087</td>
<td>2,306</td>
<td></td>
</tr>
<tr>
<td>R&amp;D</td>
<td>0.013</td>
<td>0.035</td>
<td>0.000</td>
<td>2,306</td>
<td></td>
</tr>
<tr>
<td>Fixed Investment</td>
<td>0.068</td>
<td>0.049</td>
<td>0.058</td>
<td>2,306</td>
<td></td>
</tr>
<tr>
<td>Short Term Debt</td>
<td>0.109</td>
<td>0.111</td>
<td>0.068</td>
<td>2,306</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel C: UK</th>
<th>Variable</th>
<th>$\mu$</th>
<th>$\sigma$</th>
<th>Median</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash</td>
<td>0.113</td>
<td>0.134</td>
<td>0.071</td>
<td>3,202</td>
<td></td>
</tr>
<tr>
<td>Cash Flow</td>
<td>0.077</td>
<td>0.119</td>
<td>0.097</td>
<td>3,202</td>
<td></td>
</tr>
<tr>
<td>R&amp;D</td>
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<td>0.054</td>
<td>0.000</td>
<td>3,202</td>
<td></td>
</tr>
<tr>
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<td>0.044</td>
<td>0.051</td>
<td>3,202</td>
<td></td>
</tr>
<tr>
<td>Short Term Debt</td>
<td>0.073</td>
<td>0.083</td>
<td>0.045</td>
<td>3,202</td>
<td></td>
</tr>
</tbody>
</table>
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.

Large firms in all three countries are more likely to pay dividends.
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### Table: Tabulation of Size and Dividend Payout Subsamples

<table>
<thead>
<tr>
<th>Panel</th>
<th>Small</th>
<th>Medium</th>
<th>Large</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel A: US</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Dividends</td>
<td>2,883 (16%)</td>
<td>4,899 (28%)</td>
<td>1,141 (6%)</td>
<td>8,923 (50%)</td>
</tr>
<tr>
<td>Dividends</td>
<td>797 (5%)</td>
<td>4,455 (25%)</td>
<td>3,638 (20%)</td>
<td>8,890 (50%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>3,680 (21%)</td>
<td>9,354 (52%)</td>
<td>4,779 (23%)</td>
<td>17,813 (100%)</td>
</tr>
<tr>
<td><strong>Panel B: Germany</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Dividends</td>
<td>78 (5%)</td>
<td>158 (10%)</td>
<td>53 (3%)</td>
<td>289 (18%)</td>
</tr>
<tr>
<td>Dividends</td>
<td>194 (12%)</td>
<td>654 (41%)</td>
<td>448 (28%)</td>
<td>1,296 (82%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>272 (17%)</td>
<td>812 (51%)</td>
<td>501 (31%)</td>
<td>1,585 (100%)</td>
</tr>
<tr>
<td><strong>Panel C: UK</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Dividends</td>
<td>74 (3%)</td>
<td>55 (2%)</td>
<td>15 (1%)</td>
<td>144 (5%)</td>
</tr>
<tr>
<td>Dividends</td>
<td>536 (18%)</td>
<td>1,533 (52%)</td>
<td>741 (25%)</td>
<td>2,810 (95%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>610 (21%)</td>
<td>1,588 (54%)</td>
<td>756 (26%)</td>
<td>2,954 (100%)</td>
</tr>
</tbody>
</table>
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.
- For all countries, firms have roughly similar fixed investment-to-asset ratios across different firm size categories.
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**Table:** Descriptive statistics: Size categories

<table>
<thead>
<tr>
<th>Variable</th>
<th>Small</th>
<th>Medium</th>
<th>Large</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash</td>
<td>0.205</td>
<td>0.149</td>
<td>0.088</td>
</tr>
<tr>
<td>Cash Flow</td>
<td>0.013</td>
<td>0.075</td>
<td>0.094</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>0.085</td>
<td>0.042</td>
<td>0.033</td>
</tr>
<tr>
<td>Fixed Investment</td>
<td>0.045</td>
<td>0.053</td>
<td>0.056</td>
</tr>
<tr>
<td>Short Term Debt</td>
<td>0.032</td>
<td>0.018</td>
<td>0.027</td>
</tr>
<tr>
<td>Panel B: Germany</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cash</td>
<td>0.096</td>
<td>0.076</td>
<td>0.096</td>
</tr>
<tr>
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<td>0.055</td>
<td>0.081</td>
<td>0.097</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>0.010</td>
<td>0.008</td>
<td>0.025</td>
</tr>
<tr>
<td>Fixed Investment</td>
<td>0.067</td>
<td>0.067</td>
<td>0.071</td>
</tr>
<tr>
<td>Short Term Debt</td>
<td>0.126</td>
<td>0.116</td>
<td>0.083</td>
</tr>
<tr>
<td>Panel C: UK</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cash</td>
<td>0.127</td>
<td>0.112</td>
<td>0.103</td>
</tr>
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<td>0.044</td>
<td>0.085</td>
<td>0.091</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>0.030</td>
<td>0.019</td>
<td>0.047</td>
</tr>
<tr>
<td>Fixed Investment</td>
<td>0.057</td>
<td>0.064</td>
<td>0.056</td>
</tr>
<tr>
<td>Short Term Debt</td>
<td>0.084</td>
<td>0.071</td>
<td>0.067</td>
</tr>
</tbody>
</table>
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.

The fixed investment-to-asset ratio is higher for dividend-paying firms.

The short-term debt ratio is similar across the US firms, this ratio is lower for dividend-paying companies in the UK and Germany.
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**Table: Descriptive statistics: Dividend categories**

<table>
<thead>
<tr>
<th>Panel A: US</th>
<th>No Dividends</th>
<th>Dividends</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td>$\mu$</td>
<td>$\sigma$</td>
</tr>
<tr>
<td>Cash</td>
<td>0.195</td>
<td>0.206</td>
</tr>
<tr>
<td>Cash Flow</td>
<td>0.034</td>
<td>0.155</td>
</tr>
<tr>
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<td>0.072</td>
<td>0.096</td>
</tr>
<tr>
<td>Fixed Investment</td>
<td>0.049</td>
<td>0.043</td>
</tr>
<tr>
<td>Short Term Debt</td>
<td>0.023</td>
<td>0.063</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th></th>
<th>US (1)</th>
<th>Germany (2)</th>
<th>UK (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta Cash_{t-1}$</td>
<td>-0.127***</td>
<td>-0.206**</td>
<td>-0.163***</td>
</tr>
<tr>
<td></td>
<td>(0.048)</td>
<td>(0.085)</td>
<td>(0.059)</td>
</tr>
<tr>
<td>Cash Flow$_t$</td>
<td>0.208***</td>
<td>0.139*</td>
<td>0.197***</td>
</tr>
<tr>
<td></td>
<td>(0.041)</td>
<td>(0.082)</td>
<td>(0.047)</td>
</tr>
<tr>
<td>$\Delta RD_{t+1}$</td>
<td>0.920***</td>
<td>0.616**</td>
<td>0.545**</td>
</tr>
<tr>
<td></td>
<td>(0.246)</td>
<td>(0.241)</td>
<td>(0.271)</td>
</tr>
<tr>
<td>$\Delta Fix. Investment_{t+1}$</td>
<td>0.182</td>
<td>-0.071</td>
<td>0.108</td>
</tr>
<tr>
<td></td>
<td>(0.134)</td>
<td>(0.120)</td>
<td>(0.103)</td>
</tr>
<tr>
<td>$\Delta NWC$_t$</td>
<td>-0.338***</td>
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</tr>
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<td>$\Delta Short Term Debt$_t$</td>
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<td>0.018</td>
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<td>J pvalue</td>
<td>0.112</td>
<td>0.519</td>
<td>0.725</td>
</tr>
<tr>
<td>AR(2) pvalue</td>
<td>0.172</td>
<td>0.270</td>
<td>0.965</td>
</tr>
<tr>
<td>Test $\gamma_{\Delta RD} = \gamma_{\Delta Fixlnv}$, pvalue</td>
<td>0.009</td>
<td>0.013</td>
<td>0.073</td>
</tr>
</tbody>
</table>

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

- 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 $\gamma_{\Delta \text{FixInv}}$ 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. The change in the short-term debt ratio has a negative and significant effect on savings only for UK and US firms.
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- The augmented regression model allows the classification of firms by size or dividend status to affect their coefficients on cash flow and the two types of future investment spending.

- We consider models in which only cash flow interactions are included as well as models that include interactions for both cash flow and investment.
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Empirical findings

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.

- Cash flow has the smallest effect on large firms’ saving behavior across all three countries.

- Although the differences between these effects’ magnitudes across size categories are generally not statistically significant, the point estimates clearly suggest the greater importance of cash flow for smaller firms.

- When interactions with investment are included as well, we find that future capital investment expenditures only affect US firms’ saving.
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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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<th>Germany</th>
<th>UK</th>
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</tr>
</thead>
<tbody>
<tr>
<td>$\Delta \text{Cash}_{t-1}$</td>
<td>-0.071*</td>
<td>-0.098**</td>
<td>-0.165**</td>
<td>-0.133**</td>
</tr>
<tr>
<td></td>
<td>(0.043)</td>
<td>(0.042)</td>
<td>(0.065)</td>
<td>(0.059)</td>
</tr>
<tr>
<td>Small $\times \text{CF}_t$</td>
<td>0.209***</td>
<td>0.191***</td>
<td>0.185*</td>
<td>0.202***</td>
</tr>
<tr>
<td></td>
<td>(0.045)</td>
<td>(0.047)</td>
<td>(0.097)</td>
<td>(0.065)</td>
</tr>
<tr>
<td>Medium $\times \text{CF}_t$</td>
<td>0.171***</td>
<td>0.152***</td>
<td>0.126**</td>
<td>0.183***</td>
</tr>
<tr>
<td></td>
<td>(0.039)</td>
<td>(0.055)</td>
<td>(0.060)</td>
<td>(0.056)</td>
</tr>
<tr>
<td>Large $\times \text{CF}_t$</td>
<td>0.076</td>
<td>0.027</td>
<td>0.080</td>
<td>0.136**</td>
</tr>
<tr>
<td></td>
<td>(0.089)</td>
<td>(0.051)</td>
<td>(0.094)</td>
<td>(0.060)</td>
</tr>
<tr>
<td>$\Delta RD_{t+1}$</td>
<td>0.464**</td>
<td>0.371*</td>
<td>0.412*</td>
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<tr>
<td></td>
<td>(0.185)</td>
<td>(0.200)</td>
<td>(0.219)</td>
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<td>$\Delta \text{Fix. Investment}_{t+1}$</td>
<td>0.359***</td>
<td>-0.069</td>
<td>-0.017</td>
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<td></td>
<td>(0.130)</td>
<td>(0.103)</td>
<td>(0.102)</td>
<td></td>
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<tr>
<td>$\Delta NWC_t$</td>
<td>-0.289***</td>
<td>-0.302***</td>
<td>-0.037</td>
<td>-0.073</td>
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<tr>
<td></td>
<td>(0.061)</td>
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<td>(0.050)</td>
</tr>
<tr>
<td>$\Delta \text{Short Term Debt}_t$</td>
<td>-0.167*</td>
<td>-0.227**</td>
<td>-0.001</td>
<td>0.024</td>
</tr>
<tr>
<td></td>
<td>(0.092)</td>
<td>(0.091)</td>
<td>(0.084)</td>
<td>(0.068)</td>
</tr>
<tr>
<td>Small $\times \Delta RD_{t+1}$</td>
<td>0.510**</td>
<td>0.636*</td>
<td>0.889**</td>
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<tr>
<td></td>
<td>(0.210)</td>
<td>(0.348)</td>
<td>(0.432)</td>
<td></td>
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<tr>
<td>Medium $\times \Delta RD_{t+1}$</td>
<td>0.338</td>
<td>0.080</td>
<td>0.019</td>
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<tr>
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<td>(0.275)</td>
<td>(0.188)</td>
<td>(0.837)</td>
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<tr>
<td>Large $\times \Delta RD_{t+1}$</td>
<td>0.676</td>
<td>-0.028</td>
<td>-0.239</td>
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<tr>
<td></td>
<td>(0.493)</td>
<td>(0.199)</td>
<td>(0.448)</td>
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<tr>
<td>Small $\times \Delta \text{Inv}_{t+1}$</td>
<td>0.346*</td>
<td>-0.003</td>
<td>0.252</td>
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<tr>
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<td>(0.180)</td>
<td>(0.113)</td>
<td>(0.201)</td>
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<tr>
<td>Medium $\times \Delta \text{Inv}_{t+1}$</td>
<td>-0.125</td>
<td>0.178</td>
<td>0.223</td>
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<tr>
<td></td>
<td>(0.158)</td>
<td>(0.111)</td>
<td>(0.198)</td>
<td></td>
</tr>
<tr>
<td>Large $\times \Delta \text{Inv}_{t+1}$</td>
<td>0.221</td>
<td>0.075</td>
<td>-0.442</td>
<td></td>
</tr>
<tr>
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<td>(0.136)</td>
<td>(0.208)</td>
<td>(0.445)</td>
<td></td>
</tr>
</tbody>
</table>

Firm-years 17,813 17,813 2,306 2,306 3,202 3,202
Empirical findings

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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<tr>
<td>$\Delta\text{RD}_{t+1}$</td>
<td>0.489*</td>
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</tr>
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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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- 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.
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.