Corporate investment, debt and liquidity choices

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Abstract

We study the simultaneous choice of investment, debt financing and liquidity for a large sample of US corporates between 1980 and 2014. We partition the sample according to the firms' financial constraints and their needs to hedge against future shortfalls in operating income. In contrast to results derived from isolated analyses of individual corporate decisions, our joint estimation approach shows that cash flow sensitivities of investment, net debt issuance and cash holdings are much higher for unconstrained firms than for constrained firms. Companies with high hedging needs moreover manage their ability to cover future financing needs in different ways: While unconstrained firms increase their debt issues with improving investment opportunities, constrained firms drive up their cash stocks to preserve financial flexibility. Even though the financial crisis erupting in 2007 greatly reduced the size of the cash flow sensitivities of corporate investment, financing and liquidity decisions, it left these general relations intact.

JEL Classification: G31, G32

Keywords: Cash flow sensitivity, investment, debt issuance, cash holdings

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1 Introduction

In the presence of financing frictions, sustaining financial flexibility becomes one of the most important objectives of Chief Financial Officers (Graham and Harvey, 2001). Financing frictions prevent firms from investing in valuable projects in some states of the world. Choosing policies that preserve the flexibility to respond to periods of unexpected financial shortages may therefore create value by ensuring efficient investments. In recent years, a large body of research has evolved around this topic. While the earlier literature considered mainly the link between financing frictions and investment, more recent studies focus on the relation between financing frictions and cash holdings, i.e. the cash stock that a firm has available. Few insights have so far been gained on the comprehensive choice of investment, financing and corporate liquidity.

We try to fill this gap and study simultaneous decisions on investment, net debt issuance and change in cash holdings for a large sample of US corporates between 1980 and 2014. We are particularly interested in the cash flow sensitivity of each of these variables and employ three-stage least squares (3SLS) estimation techniques to account for the endogeneity between the respective decisions. Building on the results of the earlier literature, we partition our sample not only according to companies' financial constraints but also with respect to firms' needs to hedge against future income shortfalls. We then consider four different groups of firms: Constrained firms with high / low hedging needs and unconstrained firms with high / low hedging needs. Financial constraints are gauged according to ex-ante proxies for the wedge between internal and external financing costs. High (low) hedging needs, in contrast, are measured by a negative (positive) correlation between operating cash flows and investment opportunities. While, according to the earlier literature, the distinction according to financial constraints is relevant mainly for the cash flow sensitivities of investments and cash holdings (Fazzari, Hubbard, and Petersen (1988); Almeida, Campello, and Weisbach (2004)), the latter distinction has been shown to be important for financing and liquidity decisions and the corresponding cash flow sensitivities of changes in debt levels and cash holdings (Acharya, Almeida, and Campello (2007)).

Our contribution to the literature is twofold: First and foremost, we try to enhance the earlier results on the isolated cash flow sensitivities of investment, debt and cash stocks by studying the interrelation of corporate decisions. Second, we deliberately collect a relatively broad set of U.S. firms (excluding financials and utilities) that spans several industries and time periods. This permits examination also of the post-crisis

period that purportedly affected corporate investment and financing choices to a considerable degree.

Accounting explicitly for the endogeneity between corporate decisions allows us to derive interesting new results. In particular with respect to firms' investment decisions, our conclusions are different from those of studies that look at corporate investment behavior in isolation. As one of our most important results, we detect a higher cash flow sensitivity of investment for unconstrained than for constrained companies that is particularly strong in the case of low hedging needs. This latter observation is intuitive in so far as firms with low hedging needs have the necessary internal means of financing available exactly when they are needed, i.e. when lucrative investment opportunities present themselves. As a consequence, the investment levels of those firms are positively associated with increases in cash flows. For constrained firms, we moreover find a negative sensitivity of investment to cash holdings and a particularly strong sensitivity of investment to net debt issues. This indicates that constrained firms deplete their cash stocks and use additional debt to finance their investments, the latter to an even stronger degree than unconstrained firms.

Regarding the debt financing decision, we similarly observe that unconstrained firms reduce their net debt issues with increasing cash flows to a stronger degree than constrained firms. Particularly firms with high hedging needs show a strong tendency to save debt capacity for future financing needs. Interestingly, we find that only unconstrained firms with high hedging needs increase their net debt issues with improving investment possibilities. Intuitively, firms with high hedging needs have to resort to either debt financing or depletion of cash stock when investment opportunities arise, since they cannot rely on contemporaneous cash flows. Given their easier access to public debt markets, it is reasonable that the effect of investment opportunities on debt levels should be more pronounced for unconstrained firms.

Finally, with respect to the liquidity decision, we also find a stronger cash flow sensitivity of cash holdings for unconstrained firms than for constrained firms. Paralleling the above mentioned effect of investment opportunities on net debt issues, we observe that constrained firms with high hedging needs increase their cash holdings particularly intensely with improving investment opportunities. This underlines these firms' needs to preserve financial flexibility in the face of rising investment possibilities.

In sum, our results point towards a more complex corporate decision frame than earlier studies indicated. Accounting explicitly for the endogeneity between investment, financing and liquidity choices, we find that not only the wedge between internal and external financing costs (i.e. financing constraints) plays an important role but so does the wedge between investment proceeds and investment opportunities (i.e. hedging needs). Cash flow sensitivities are particularly large for unconstrained firms and weakest for constrained

firms with low hedging needs. Among firms with high hedging needs, an interesting pattern arises with regard to how they manage their financial flexibility for future investment opportunities: While unconstrained firms employ higher debt levels, constrained firms drive up their cash stocks. These latter relations remain intact even after controlling for additional agency conflict and risk management effects and are also observed after the financial crisis 2007/08.

The paper is organized as follows: Section 2 gives a brief overview of the related literature. Section 3 describes the main features of our dataset and of our empirical methodology. Section 4 presents the main results and Section 5 considers additional factors. In Section 6 we conclude.

2 Related literature

Whereas the traditional valuation approach following Modigliani and Miller (1958) ascribes no value to capital structure choices and sees cash stocks (i.e. accumulated past cash flows) simply as the mirror image of "negative debt", a large body of research has recently investigated the economic role of financing and current and past cash flows. The studies show that not only investment decisions but also cash policies are value enhancing in a world with financing frictions that entail high costs to external financing activities.

Fazzari, Hubbard, and Petersen (1988) are among the first to argue that when external financing is more expensive than internal financing, investment decisions of constrained firms are highly sensitive to changes in cash flow. Studies in this vein traditionally employ a reduced-form investment Q model, which controls for firms' investment opportunities. In the empirical tests, a sample of firms is subdivided according to a priori measures of financing constraints and investment-cash flow sensitivities of the different subsamples are compared (see also Hoshi, Kashyap, and Scharfstein (1991)).

In contrast, Kaplan and Zingales (1997) report that investment-cash flow sensitivities are non-monotonic in the degree of financing constraints. In essence, they show that the least constrained firms exhibit the highest sensitivities. They conclude that high cash flow sensitivities of investment cannot unequivocally be interpreted as signs of financial constraints and identify a set of alternative criteria that help determine the degree of financing constraints in a company.

From an agency perspective, a high cash flow sensitivity of investment may also reflect managers' tendency to overinvest when they have access to internal funds (Jensen (1986)), independent of the existence of financial constraints. Pawlina and Renneboog (2005) test the relation between investment and cash flow in a

corporate governance framework on a sample of listed UK firms between 1992 and 1998. They find evidence of overinvestment where the presence of large outside blockholders mitigates the free cash flow problem.

Hovakimian and Hovakimian (2009) reconsider the use of ex-ante proxies for financial constraints and examine the development of investment-cash flow sensitivities along the cash flow cycle. Using a large sample of US firms between 1985 and 2003, they find that cash flow sensitive firms face financial constraints, but the severity of these constraints varies across the cash flow cycle. They explicate that investment-cash flow sensitivity is associated with underinvestment when cash flows are low and with overinvestment when cash flows are high.

Almeida and Campello (2007) re-examine the monotonicity of cash flow sensitivities of investment along financial constraints as claimed by Fazzari, Hubbard, and Petersen (1988). Using a sample of manufacturing firms in the US between 1985 and 2000, they find that asset tangibility positively and significantly affects the cash flow sensitivity of investment of financially constrained firms, but that tangibility drives no shifts in those same sensitivities when firms are unconstrained. The authors argue that a simple credit multiplier effect allows constrained firms a higher borrowing capacity if they invest in assets with a higher degree of tangibility. This is because more pledgable (i.e. tangible) assets allow an easier use as collateral for new debt issuances.

Almeida, Campello, and Weisbach (2004) study the cash flow sensitivity of cash rather than investment in a sample of US manufacturing firms over the 1971 to 2000 period. They observe that only financially constrained firms show a positive cash flow sensitivity of cash. This result supports the intuition that constrained firms feel a particular need to save cash out of cash flow in order to consistently uphold their ability to invest in valuable projects. Bates, Kahle, and Stulz (2009) study a large sample of industrial firms in the US between 1980 and 2006 and show a general inclination of firms to increase their cash holdings with increasing volatility of their cash flows. They argue that the precautionary motive to hold cash has increased in importance over time whereas they do not find evidence for an increase in agency conflicts leading to higher cash holdings.

Denis and Sibilkov (2010) follow up on the question why cash holdings appear to be more valuable for financially constrained firms than for unconstrained firms. They examine a broad sample of US firms between 1985 and 2006. They find that cash holdings are positively associated with capital expenditures for financially constrained firms and that for these firms the association between investment and firm value is significantly stronger than for unconstrained firms. Despite the benefits of higher cash holdings for constrained

firms, the authors show that some of these firms nevertheless hold only small cash balances as they already spend their available cash flows on investment projects without any further ability to build cash reserves.

Acharya, Almeida, and Campello (2007) focus more closely on the impact of financing frictions on the tradeoff between debt and cash holdings. They argue that "both higher cash stocks and lower debt levels today increase a constrained firm's future funding capacity and, thus, its ability to undertake new investment opportunities." However, in low cash flow states, the effect of cash on investment will be higher, whereas in high cash flow states, the effect from reducing debt will be higher. Cash and debt are, hence, no longer substitutes when financing is not frictionless. Testing their theoretical predictions on a sample of manufacturing firms between 1971 and 2001, the authors find that unconstrained firms use their free cash flows to reduce their level of debt rather than save it as cash. Constrained firms, in contrast, vary their cash-debt tradeoff in correspondence with their hedging needs. If they have high hedging needs, they show a strong propensity to save cash out of cash flows. If their hedging needs are low, in contrast, they use excess cash flows to reduce their amount of debt.

In the following analysis, we will try to bring these - partly contradictory - results into a unified framework. Our main focus is on the cash flow sensitivity of investment, net debt issues and changes in cash holdings when accounting for the endogeneity of the corresponding investment, financing and liquidity decisions. Based on the literature cited above, we will also test the impact of additional factors such as asset tangibility and volatility of cash flows.

Our results confirm some of the earlier findings but refute others. Supporting Kaplan and Zingales (1997), we also report non-monotonic cash flow sensitivities of investments. Our observation of a higher investment-cash flow sensitivity for unconstrained than for constrained firms could be interpreted as evidence of overinvestment among the former and underinvestment among the latter group of firms, akin to Hovakimian and Hovakimian (2009). This is because constrained companies in our sample show much lower cash flow levels (as will be shown in Table 1 in Section 3). Similar to Acharya, Almeida, and Campello (2007) we find that constrained firms show a cash flow sensitivity of cash holdings that varies with their hedging needs. However, and in contrast to the authors, we also observe the same pattern with regard to the cash flow sensitivity of net debt issues. Furthermore, unconstrained firms in our sample both reduce their debt levels and raise their cash stocks with increasing cash flows. While parts of these differences may be driven by our more heterogeneous firm sample, accounting explicitly for the endogeneity of three simultaneous corporate decisions can be expected to also contribute to the new findings.

3 Sample selection and data description

Our sample consists of public companies incorporated in the United States with financial data available from the quarterly COMPUSTAT database over the period January 1980 to September 2014. We exclude banks, insurance companies and other financial firms (SIC 6000-6999) as their investments and accounting data differ from those of industrial and commercial firms. We also exclude utilities (SIC 4000-4999) whose investment and financing choices are highly regulated. We deflate all dollar series to 1980 dollars.

Our data selection criteria and variable construction approach mainly follows that of Almeida, Campello, and Weisbach (2004), Acharya, Almeida, and Campello (2007) and Kahle and Stulz (2013). We drop from the raw data those firm-quarter observations for which total assets, sales, or cash and marketable securities are negative. We also retain only those observations for which total assets and sales growth is less than 100%. This procedure ensures that we solely consider firms that are not too strongly impaired by extreme corporate events leading to large jumps in their business fundamentals. Furthermore, we discard firm-quarter observations for which cash and marketable securities are greater than total assets or for which short- or long-term debt exceeds total assets. Firms with debt balances exceeding total assets are close to bankruptcy leading to distinct, non-standard financing and investment policies. Finally, we also eliminate those firms whose Q is either negative or larger than 10. This procedure follows Gilchrist and Himmelberg (1995), Almeida, Campello, and Weisbach (2004), Acharya, Almeida, and Campello (2007) and attempts to reduce problems in the measurement of investment opportunities. Our final sample consists of 612,335 firm-quarter observations.

As regards variable construction,[1] we define $\Delta Debt$ as the ratio of net long-term debt issuances (COMPUSTAT item #86 - item #92) to total book value of assets (item #44), and $\Delta CashHold$ as the changes in the holdings of cash and cash equivalents (item #74) divided by total assets. Our investment variable *Invest* is defined as the ratio of capital expenditures (item #90) to the beginning-of-period value of total assets. We calculate *CashFlow* as the ratio of income before extraordinary items plus depreciation and amortization (item #8 + item #5) to lagged total assets.

[1] The following item references are to *quarterly* COMPUSTAT data.

We estimate the following empirical model in a 3SLS system:

$$
\begin{aligned}
Invest_{i,t} &= \alpha_0 + \alpha_1 CashFlow_{i,t} + \alpha_2 Q_{i,t} + \alpha_3 Size_{i,t} + \alpha_4 \Delta Debt_{i,t} \\
&\quad + \alpha_5 \Delta CashHold_{i,t} + \alpha_6 Invest_{i,t-1} + \sum_i firm_i + \sum_t quarter_t + E_{i,t} \quad (1) \\
\Delta Debt_{i,t} &= \beta_0 + \beta_1 CashFlow_{i,t} + \beta_2 Q_{i,t} + \beta_3 Size_{i,t} + \beta_4 \Delta CashHold_{i,t} \\
&\quad + \beta_5 Invest_{i,t} + \beta_6 Debt_{i,t-1} + \sum_i firm_i + \sum_t quarter_t + e_{i,t} \quad (2) \\
\Delta CashHold_{i,t} &= \gamma_0 + \gamma_1 CashFlow_{i,t} + \gamma_2 Q_{i,t} + \gamma_3 Size_{i,t} + \gamma_4 \Delta Debt_{i,t} \\
&\quad + \gamma_5 Invest_{i,t} + \gamma_6 CashHold_{i,t-1} + \sum_i firm_i + \sum_t quarter_t + \epsilon_{i,t} \quad (3)
\end{aligned}
$$

Size is calculated as the natural logarithm of total assets and controls for economies of scale in both investment, cash management and financing choice. Our proxy for investment opportunities, *Q*, is calculated as the sum of total book debt and market value of equity less inventories divided by lagged total assets ((item #51 + item #45) + (item #14 x item #61) - item #38) / item #44). This procedure follows Chava and Roberts (2008), but for reasons of consistency we divide by total assets rather than total capital. Lagged levels of the dependent variables are used as additional regressors to identify the system. *Debt* is defined as COMPUSTAT item #51 divided by item #44 and *CashHold* is item #36 divided by item #44. Variables *firm* and *quarter* absorb firm- and time-specific effects, respectively.

In some specifications we also include the independent variables *Intang*, which is defined as the ratio of a firm's intangible assets to its total assets, and the volatility of the cash flows *CFVol*, which we define on the basis of Opler, Pinkowitz, Stulz, and Williamson (1999) as a firm's standard deviation of cash flows over the previous 40 quarters.

In the literature, several methods for identifying the level of financial constraints have been employed. We use different approaches to sort firms into financially constrained and unconstrained categories: In general (Sections 4.1 to 4.3, Section 5), we report results based on a partition according to the payout ratio. I.e., we rank the firms in our sample according to their payout ratio (dividends and repurchases to operating income) for each quarter of the observation period. We assign to the group of constrained (unconstrained) firms those in the bottom (top) three deciles of the payout distribution. We also partition the sample according to size, assigning to the group of constrained (unconstrained) firms those in the bottom (top) three deciles of the size distribution per quarter. Finally, we also use the lack of a bond rating as a proxy for financial

constraints. Given that firms may also choose not to use debt and therefore do not solicit a credit rating, we require that constrained firms do not have a public credit rating while reporting positive debt at the same time (see also Faulkender and Petersen (2006)). As unconstrained firms, we define companies with an investment grade rating (AAA to BBB). We deliberately leave out the group of companies with sub-investment grade rating (BB to D) as for these firms a discrete debt market developed over our examination period with unique characteristics that may not be seen as representative for the remaining group of rated firms. These three different partitioning approaches follow Fazzari, Hubbard, and Petersen (1988) and have since been used extensively in the literature.

With regard to identifying firms with high or low needs for hedging, we follow Acharya, Almeida, and Campello (2007). The basic problem in classifying the relationship between a firm's operating cash flows and investment opportunities is that the typical proxies for investment possibilities are not exogenous to cash flows. Acharya, Almeida, and Campello (2007) suggest several approaches to circumvent these difficulties of which we choose the following: We calculate the correlation between a firm's operating cash flow and its industry-level median of R&D expenses, using the firm's two-digit SIC code. This correlation effectively proxies for the correlation between the supply of internal funds and the investment demand facing each firm. We then assign to the group of high hedging needs those firms with empirical correlation below -0.2 and to the group of low hedging needs those with correlation above 0.2.

Table 1 presents univariate comparisons of firm characteristics for the four different subsamples. The reported data differentiate between the three approaches of measuring financial constraints (payout policy, firms size and bond rating). For instance, according to the payout scheme in Panel A, there are overall 271,057 (146,674) firm-quarter observations that are financially constrained (unconstrained). Among these, 19,137 (10,491) firm-quarter observations are from firms with high hedging needs and 17,873 (12,447) from firms with low hedging needs. For the partition according to bond ratings in Panel C, note that the number of unconstrained observations is strongly reduced as these are from firms with investment-grade rating, which make up only a relatively small proportion of our total sample.

As our sampling firms come from different industries and since we do not discard the smallest firms (we keep firms with market capitalization less than $10 million in our dataset), it is not surprising that our data display slightly different characteristics as compared to earlier studies. In particular, leverage ratios in our dataset are a bit smaller and values of Q are higher as compared to the samples of, e.g., Almeida, Campello, and Weisbach (2004) or Acharya, Almeida, and Campello (2007). Consistent with earlier studies,

however, cash holdings are higher and net debt issues are lower for constrained than for unconstrained firms in our sample. We also observe that constrained firms in our sample show smaller changes in cash stocks, have lower cash flows (even partly negative) that are more volatile. Finally, constrained firms are smaller, display higher Q and employ fewer intangibles than unconstrained firms. However, there does not seem to be evidence of significant variation in proxy distribution between firms with high and low hedging needs within the same constraint type. In particular, there are hardly any differences between the different sub-samples with respect to their investment levels.

Table 1: Summary Statistics for Financial Constraints and Hedging Needs

This table displays summary statistics for investments (Invest), holdings of cash and liquid securities (CashHold), changes in cash holdings (ΔCashHold), long-term debt (Debt), net debt issuance (ΔDebt), cash flow (CashFlow), the natural logarithm of total assets (Size), Tobin's q (Q), intangible assets (Intang) and cash flow volatility (CFVol). All level variables are deflated by total assets. Financial constraints are determined via the firms' payout ratio (Panel A), the firms' size (Panel B) or the rating (Panel C). Hedging needs are measured based on the correlation between a firm's cash flow and industry-level R&D expenses. All data are from the quarterly COMPUSTAT industrial tapes between January 1980 and September 2014.

		Variable Mean (Median)									
Financial Constraints Criteria		Invest	CashHold	ΔCashHold	Debt	ΔDebt	CashFlow	Size	Q	Intang	CFVol
Panel A: Payout Policy											
Constrained Firms	High Hedging Needs	0.0242	0.2905	-0.0417	0.1130	0.0025	-0.0542	2.5751	3.1841	0.1654	0.9305
	[N=19,137]	(0.0116)	(0.1972)	(-0.0080)	(0.0193)	(0.0000)	(-0.0062)	(2.5584)	(2.5057)	(0.0620)	(0.0564)
	Low Hedging Needs	0.0236	0.2453	-0.0457	0.1260	0.0011	-0.0029	2.7481	2.8104	0.1400	0.6192
	[N=17,873]	(0.0123)	(0.1423)	(-0.0033)	(0.0327)	(0.0000)	(0.0069)	(2.6948)	(2.0786)	(0.0392)	(0.0399)
Unconstrained Firms	High Hedging Needs	0.0253	0.1624	0.0004	0.1455	0.0040	0.0271	5.4162	2.8936	0.2106	0.1413
	[N=10,491]	(0.0191)	(0.0921)	(0.0011)	(0.1143)	(0.0000)	(0.0266)	(5.3325)	(2.2353)	(0.1633)	(0 .0154)
	Low Hedging Needs	0.0249	0.1527	0.0007	0.1387	0.0045	0.0278	5.3675	2.8237	0.2328	0.0241
	[N=12,447]	(0.0187)	(0.0873)	(0.0012)	(0.1069)	(0.0000)	(0.0275)	(5.3861)	(2.2772)	(0.1897)	(0.0133)
Panel B: Firm Size											
Constrained Firms	High Hedging Needs	0.0225	0.2822	-0.0640	0.0907	0.0004	-0.0574	1.1747	3.1962	0.1365	1.4911
	[N=11,808]	(0.0083)	(0.1834)	(-0.0136)	(0.0111)	(0.0000)	(-0.0154)	(1.3749)	(2.4960)	(0.0168)	(0.0721)
	Low Hedging Needs	0.0208	0.2428	-0.0849	0.0928	0.0013	-0.0606	1.2496	2.7735	0.0999	0.8755
	[N=10,654]	(0.0082)	(0.1402)	(-0.0093)	(0.0158)	(0.0000)	(-0.0018)	(1.5120)	(1.9662)	(0.0000)	(0.0571)
Unconstrained Firms	High Hedging Needs	0.0263	0.1303	0.0030	0.2159	0.0053	0.0201	6.7421	2.7694	0.2540	0.1368
	[N=10,651]	(0.0200)	(0.0696)	(0.0012)	(0.1865)	(-0.0001)	(0.0230)	(6.4517)	(2.1218)	(0.2110)	(0.0138)
	Low Hedging Needs	0.0258	0.1177	0.0045	0.2100	0.0076	0.0232	6.5453	2.7575	0.2733	0.0219
	[N=12,593]	(0.0194)	(0.0614)	(0.0015)	(0.1793)	(-0.0000)	(0.0248)	(6.2633)	(2.2313)	(0.2335)	(0.0126)
Panel C: Bond Rating											
Constrained Firms	High Hedging Needs	0.0264	0.2268	-0.0275	0.1246	0.0045	-0.0249	2.7964	2.9992	0.1869	0.5222
	[N=21,656]	(0.0139)	(0.1299)	(-0.0039)	(0.0583)	(-0.0010)	(0.0097)	(2.8485)	(2.3082)	(0.0954)	(0.0461)
	Low Hedging Needs	0.0247	0.1881	-0.0191	0.1249	0.0039	-0.0127	2.8885	2.6905	0.1622	0.4114
	[N=20,271]	(0.0145)	(0.0982)	(-0.0019)	(0.0648)	(-0.0009)	(0.0163)	(2.8934)	(1.9690)	(0.0894)	(0.0327)
Unconstrained Firms	High Hedging Needs	0.0278	0.0821	0.0028	0.1919	0.0070	0.0279	8.0110	2.8252	0.1924	0.0140
	[N=3,162]	(0.0239)	(0.0538)	(0.0012)	(0.1775)	(-0.0001)	(0.0275)	(7.7444)	(2.2348)	(0.1685)	(0.0099)
	Low Hedging Needs	0.0260	0.0783	0.0026	0.1827	0.0073	0.0283	7.6878	3.0011	0.2988	0.0128
	[N=4,108]	(0.0215)	(0.0412)	(0.0016)	(0.1735)	(-0.0001)	(0.0278)	(7.4247)	(2.4893)	(0.2644)	(0.0097)

4 Results

This section presents the results from our 3SLS system estimation across the four subsamples of firms, i.e. the partitions of constrained / unconstrained firms and of firms with low / high hedging needs (constraints are measured via the payout ratio).[2] While the investment, debt and cash models have been jointly estimated within constraint types, we discuss the results in individual subsections for ease of exposition. As we are interested in the comprehensive choice of investment, financing and liquidity, we do not only report the cash flow sensitivities (i.e. parameters α_1, β_1 and γ_1 from equations (1) to (3)) but all estimated coefficients.

4.1 Investments

Table 2 reports the results from the investment Equation (1) for constrained firms in the two leftmost columns and for unconstrained firms in the two rightmost columns. In contrast to much of the earlier literature, we find that unconstrained firms show a high cash flow sensitivity of investment. For each Dollar of additional cash flow, these firms invest between 4 Cents (low hedging needs) and 2 Cents (high hedging needs) more. Among constrained firms, a significant cash flow sensitivity is obtained only for firms with high hedging needs. This sensitivity coefficient is, however, much smaller: For each additional Dollar of cash flow, they invest half a Cent more.

Investment-cash flow sensitivities are hence not only influenced by the degree of financial constraints but also by the correlation between cash flows and investment opportunities, i.e. hedging needs. Interestingly, while among unconstrained firms those with low hedging needs display a stronger dependency of investment on cash flows, among constrained firms only those with high hedging needs display any significant sensitivity. How can this be explained? For firms with low hedging needs, cash inflows tend to coincide with investment opportunities. As a consequence, these firms should invest more with increasing cash flows conditional on having positive cash flows. This, however, is not necessarily the case for the constrained firms in our sample, as Table 1 reports negative mean cash flows for these firms. It is hence reasonable that we do not observe a significant cash flow sensitivity for the constrained firms with low hedging needs, while we do for the unconstrained firms.

We furthermore find that constrained firms reduce their cash stocks in order to invest (for 1 Dollar less in cash holdings, investments increase by about 2 Cents), while no such effect is obtained for unconstrained

[2] Results for the alternative constraint proxies are presented in Section 4.4.

Table 2: Choice of Investment

This table displays 3SLS results (including firm and quarter fixed effects) of the empirical model for investments (see Eqs. (1) to (3)). The endogenous dependent variable is Invest. Financial constraints are determined via the firm's payout ratio. Hedging needs are measured based on the correlation between a firm's cash flow and industry-level R&D expenses. All data are from the quarterly COMPUSTAT industrial tapes between January 1980 and September 2014. Investment, debt and cash models are jointly estimated. t-statistics are in parentheses. $*$, $**$ and $***$ indicate statistical significance at the 10-, 5- and 1-percent level, respectively.

	Constrained		Unconstrained	
	Hedging Needs High	Hedging Needs Low	Hedging Needs High	Hedging Needs Low
CashFlow	0.0049**	-0.0016	0.0234**	0.0403***
	(2.557)	(-0.421)	(2.224)	(4.247)
ΔCashHold	-0.0179***	-0.0185*	-0.0033	-0.0003
	(-2.713)	(-1.883)	(-0.304)	(-0.034)
ΔDebt	0.2231***	0.1986***	0.1109***	0.1042***
	(3.971)	(3.258)	(4.729)	(6.165)
Q	0.0014***	0.0015***	0.0011***	0.0013***
	(6.374)	(5.963)	(4.548)	(7.400)
Size	0.0002	0.0042**	-0.0017**	-0.0021***
	(0.355)	(2.383)	(-2.310)	(-3.942)
L.Invest	0.1899***	0.1228***	0.1327***	0.3329***
	(15.320)	(12.270)	(12.469)	(33.608)
Constant	0.0153	-0.0144	0.0306***	0.0098
	(0.446)	(-0.670)	(2.727)	(0.774)
N	19,137	17,873	10,491	12,447

firms. In other words, holding higher cash stocks appears to be particularly important for constrained firms in order to uphold their investment activities. Additionally, constrained firms issue more debt for investment than do unconstrained firms. For an additional Dollar issued as debt, constrained firms increase their investments by roughly 20 Cents, whereas unconstrained firms increase their investments only by about 10 Cents.

From the sensitivities of investment towards cash flows, changes in cash stocks and changes in debt levels, we can hence draw an ordering of the importance of financing sources for capital expenditures. For unconstrained firms, the strongest impact on investment is achieved by an increase in debt followed by a rise in cash flows. For constrained firms, in contrast, raising debt increases the level of investment most strongly, followed by a draw down from cash stocks. Only for constrained firms with high hedging needs will also an increase in cash flows trigger higher investments.

4.2 Net debt issues

Table 3 presents results from Equation (2) on net debt issues. Quite similarly to the results from the investment equation, we do not find significant cash flow sensitivities for constrained firms with low hedging needs. Rather, unconstrained firms with both low and high hedging needs appear to reduce their debt levels by about 11 Cents per Dollar of additional cash flow, and constrained firms with high hedging needs reduce their debt levels by about 2 Cents. For unconstrained firms, the degree of hedging needs hence does not seem to play a role for their intent to save debt capacity from current cash flow, while it does for constrained firms. The first part of this observation supports the earlier findings by Acharya, Almeida, and Campello (2007), but with regard to the second the authors find a positive cash flow sensitivity of debt issues for constrained firms with low rather than high hedging needs.

Table 3: Choice of Debt

This table displays 3SLS results (including firm and quarter fixed effects) of the empirical model for net debt issues (see Eqs. (1) to (3)). The endogenous dependent variable is ΔDebt. Financial constraints are determined via the firm's payout ratio. Hedging needs are measured based on the correlation between a firm's cash flow and industry-level R&D expenses. All data are from the quarterly COMPUSTAT industrial tapes between January 1980 and September 2014. Investment, debt and cash models are jointly estimated. t-statistics are in parentheses. $*, **$ and $***$ indicate statistical significance at the 10-, 5- and 1-percent level, respectively.

	Constrained		Unconstrained	
	Hedging Needs High	Hedging Needs Low	Hedging Needs High	Hedging Needs Low
CashFlow	-0.0193***	0.0051	-0.1112***	-0.1132***
	(-4.692)	(0.433)	(-3.379)	(-2.975)
ΔCashHold	0.0748***	0.0845***	0.1296***	0.0761**
	(5.607)	(3.152)	(4.083)	(2.387)
Invest	0.7111***	0.5296**	0.6772***	0.5043***
	(7.200)	(2.535)	(2.925)	(4.706)
Q	0.0004	0.0006	0.0021***	-0.0007
	(0.652)	(0.748)	(2.613)	(-0.993)
Size	0.0056***	-0.0129**	0.0186***	0.0162***
	(3.847)	(-2.477)	(8.184)	(8.143)
L.Debt	-0.0474***	-0.0463***	-0.1238***	-0.1266***
	(-5.725)	(-4.475)	(-11.521)	(-13.775)
Constant	0.0287	0.0856	-0.0500	-0.0172
	(0.323)	(1.267)	(-1.362)	(-0.340)
N	19,137	17,873	10,491	12,447

All firms display a significantly positive association between changes in cash stock and in debt levels. The effect is particularly strong for unconstrained firms with high hedging needs. For this group of firms, a

further interesting result is derived: A significantly positive association between investment opportunities (as proxied by Q) and net debt issues. Hence, unconstrained firms with high hedging needs increase their debt levels more strongly if their investment possibilities improve. Due to their high hedging needs, this appears a reasonable strategy because internal means of financing will usually not be available when future investment projects present themselves. Constrained firms may find it much harder or costly to tap public debt markets, which may explain why we observe the significant effect of investment opportunities on net debt issues only for unconstrained firms with high hedging needs, but not for constrained firms.

4.3 Cash holdings

Table 4 reports the final results from the joint 3SLS estimation model on changes in cash holdings from Equation (3). Similar to the results from the investment and debt equation, we observe significant cash flow sensitivities of cash holdings only for unconstrained firms (with both high and low hedging needs) and for constrained firms with high hedging needs. Essentially, unconstrained firms save about 56 Cents from an additional Dollar of cash flow, while constrained firms with high hedging needs save only about 8 Cents.

Supporting the earlier results, we also observe a positive association between net debt issues and changes in cash holdings for unconstrained firms (with both high and low hedging needs) and for constrained firms with high hedging needs. For the latter group of firms, this effect is particularly intense. We furthermore find a significantly negative association between investment and changes in cash stocks that is particularly strong for constrained firms. This corroborates our earlier results from the investment equation where we showed that constrained firms rely on drawing down their cash stocks to finance investments.

Finally, it is interesting to note that constrained firms with high hedging needs appear to increase their cash holdings particularly strongly with improving investment opportunities. Given the negative correlation between current cash flows and investment possibilities for these firms, it is important for them to preserve the flexibility to finance future investment projects should they arise. As the costs of external financing are much higher for constrained than for unconstrained firms, it is a reasonable strategy for the former to hold higher cash balances with improving investment opportunities.

4.4 Robustness

Our results so far do not fall in line with the early comparisons between financially constrained and unconstrained firms (Fazzari, Hubbard, and Petersen (1988) or Hoshi, Kashyap, and Scharfstein (1991)) as

Table 4: Choice of Cash

This table displays 3SLS results (including firm and quarter fixed effects) of the empirical model for changes in cash holdings (see Eqs. (1) to (3)). The endogenous dependent variable is ΔCashHold. Financial constraints are determined via the firm's payout ratio. Hedging needs are measured based on the correlation between a firm's cash flow and industry-level R&D expenses. All data are from the quarterly COMPUSTAT industrial tapes between January 1980 and September 2014. Investment, debt and cash models are jointly estimated. t-statistics are in parentheses. $*$, $**$ and $***$ indicate statistical significance at the 10-, 5- and 1-percent level, respectively.

	Constrained		Unconstrained	
	Hedging Needs High	Hedging Needs Low	Hedging Needs High	Hedging Needs Low
CashFlow	0.0774***	-0.0584	0.5619***	0.5617***
	(3.340)	(-0.581)	(12.476)	(12.600)
ΔDebt	1.8334**	1.7061	0.6285***	0.2026**
	(2.458)	(1.034)	(5.114)	(2.142)
Invest	-2.0624***	-3.1609*	-1.6883***	-0.6635***
	(-2.835)	(-1.687)	(-4.373)	(-4.249)
Q	0.0062**	0.0034	0.0038***	0.0035***
	(2.137)	(0.461)	(2.964)	(3.670)
Size	0.0097	0.1768***	-0.0021	-0.0054*
	(1.166)	(11.521)	(-0.542)	(-1.891)
L.CashHold	-0.3856***	-0.2691***	-0.2831***	-0.2749***
	(-10.930)	(-3.434)	(-18.567)	(-23.295)
Constant	0.0276	-0.5514	0.0423	0.1514**
	(0.064)	(-0.974)	(0.737)	(2.263)
N	19,137	17,873	10,491	12,447

we find larger cash flow sensitivities for unconstrained rather than constrained firms. Unlike Kaplan and Zingales (1997), however, we do not examine the question of monotonicity of cash flow sensitivities along with financial constraints either. Rather, we study four distinct groups of companies, differentiating along two dimensions of which only one is determined by financial constraints. The other dimension inherently captures the wedge between a firm's current generation of and future demand for cash. The way these two dimensions are measured may therefore strongly impact our conclusions. In order to test the robustness of our results, we consider two alternative approaches of proxying financial constraints, one relying on firm size and the other on the existence of an investment-grade bond rating.

Tables 5 and 6 present the results from the joint estimation of Equations (1) to (3) based on the partitions according to firm size and bond rating. As can be seen, the results are very similar to the findings presented in the previous subsections. In particular, cash flow sensitivities are more pronounced for unconstrained firms than for constrained firms in both partitions. Also, constrained firms appear to make use of their cash

stocks in addition to drawing down debt to finance their investments (though in the partition according to size, unconstrained firms with high hedging needs seem to make use of a similar strategy). And we still find in both partitions that firms with high hedging needs increase their cash holdings with improving investment opportunities if they are constrained but issue more debt if they are unconstrained.

Table 5: 3SLS Joint Regression Results: Size Partition

This table displays 3SLS results (including firm and quarter fixed effects) of the empirical model for investment, net debt issuance and changes in cash holdings (see Eqs. (1) to (3)). Financial constraints are determined via the firms' size. Hedging needs are measured based on the correlation between a firm's cash flow and industry-level R&D expenses. All data are from the quarterly COMPUSTAT industrial tapes between January 1980 and September 2014. Investment, debt and cash models are jointly estimated. t-statistics are in parentheses. $*$, $**$ and $***$ indicate statistical significance at the 10-, 5- and 1-percent level, respectively.

	Constrained + High Hedging Needs			Constrained + Low Hedging Needs			Unconstrained + High Hedging Needs			Unconstrained + Low Hedging Needs		
	ΔDebt	ΔCashHold	Invest	ΔDebt	ΔCashHold	Invest	ΔDebt	ΔCashHold	Invest	ΔDebt	ΔCashHold	Invest
CashFlow	-0.0214***	0.0764**	0.0073**	0.0609	-0.6704***	-0.0127**	-0.0417	0.2437***	0.0327***	-0.1083***	0.3552***	0.0309***
	(-4.030)	(2.439)	(2.470)	(1.512)	(-3.471)	(-2.196)	(-1.594)	(8.394)	(5.320)	(-3.195)	(11.126)	(5.651)
ΔCashHold	0.0743***		-0.0289***	0.1169**		-0.0105	0.1237***		-0.0350***	0.0776*		0.0062
	(4.406)		(-3.077)	(2.425)		(-1.151)	(3.171)		(-3.619)	(1.934)		(0.945)
ΔDebt		1.5336	0.3187***		-1.7313	-0.0147		0.2033*	0.1053***		0.3164***	0.0444***
		(1.400)	(3.441)		(-0.397)	(-0.177)		(1.834)	(4.867)		(4.653)	(4.123)
Invest	0.4547**	-1.8170*		1.7072	-13.6111*		0.5001***	-0.4181***		0.5869***	-0.7358***	
	(2.325)	(-1.690)		(1.246)	(-1.650)		(5.138)	(-3.206)		(6.759)	(-7.489)	
L.CashHold		-0.4677***			-0.4837**			-0.2881***			-0.2800***	
		(-8.439)			(-2.012)			(-20.281)			(-24.158)	
L.Debt	-0.0537***			-0.0573**			-0.0902***			-0.1198***		
	(-3.825)			(-2.145)			(-10.199)			(-14.391)		
L.Invest			0.1440***			0.0479***			0.4034***			0.5100***
			(9.252)			(3.925)			(36.399)			(62.421)
Q	-0.0000	0.0070*	0.0012***	-0.0033	0.0353	0.0021***	0.0041***	0.0040***	0.0010***	0.0021**	0.0033***	0.0014***
	(-0.011)	(1.671)	(3.216)	(-0.953)	(1.547)	(7.127)	(5.121)	(3.604)	(4.385)	(2.557)	(3.734)	(10.040)
Size	0.0071**	0.0398**	0.0014	-0.0697**	0.6461***	0.0106**	0.0117***	-0.0015	-0.0020***	0.0154***	-0.0114***	-0.0018***
	(2.477)	(2.364)	(0.996)	(-2.127)	(10.962)	(2.091)	(5.192)	(-0.530)	(-3.392)	(7.278)	(-4.823)	(-4.969)
Constant	-0.0675	0.0747	0.0444	0.2314	-1.0556	-0.0156	-0.0886	0.0086	0.0258*	-0.0996	0.1046	0.0061
	(-0.635)	(0.146)	(0.963)	(1.342)	(-0.785)	(-0.481)	(-1.437)	(0.119)	(1.761)	(-1.453)	(1.510)	(0.551)
N	11,808	11,808	11,808	10,654	10,654	10,654	10,651	10,651	10,651	12,593	12,593	12,593

Table 6: 3SLS Joint Regression Results: Rating Partition

This table displays 3SLS results (including firm and quarter fixed effects) of the empirical model for investment, net debt issuance and changes in cash holdings (see Eqs. (1) to (3)). Financial constraints are determined via the firms' bond rating. Hedging needs are measured based on the correlation between a firm's cash flow and industry-level R&D expenses. All data are from the quarterly COMPUSTAT industrial tapes between January 1980 and September 2014. Investment, debt and cash models are jointly estimated. t-statistics are in parentheses. $*$, $**$ and $***$ indicate statistical significance at the 10-, 5- and 1-percent level, respectively.

	Constrained + High Hedging Needs			Constrained + Low Hedging Needs			Unconstrained + High Hedging Needs			Unconstrained + Low Hedging Needs		
	ΔDebt	ΔCashHold	Invest	ΔDebt	ΔCashHold	Invest	ΔDebt	ΔCashHold	Invest	ΔDebt	ΔCashHold	Invest
CashFlow	-0.1446***	0.2524***	0.0423***	-0.0545***	0.1519***	0.0092***	-0.3150***	0.3541***	0.0734***	-0.1377*	0.3474***	0.0405***
	(-13.988)	(9.693)	(7.071)	(-5.683)	(9.195)	(2.682)	(-3.681)	(4.654)	(3.094)	(-1.751)	(5.381)	(3.287)
ΔCashHold	0.1228***		-0.0432***	0.0900***		-0.01900***	0.3742***		-0.0334	0.2037***		0.0024
	(7.499)		(-5.995)	(5.340)		(-3.260)	(5.015)		(-1.425)	(2.729)		(0.189)
ΔDebt		0.6851***	0.2235***		0.2648*	0.1100***		0.2110**	0.1288***		0.1780	0.0598***
		(4.359)	(6.819)		(1.801)	(3.955)		(2.169)	(4.837)		(1.612)	(2.994)
Invest	0.5750***	-0.7716***		0.4790***	-1.2877***		0.5114**	-0.398197		0.6084***	-0.4104**	
	(6.538)	(-4.176)		(3.464)	(-5.345)		(2.008)	(-1.572)		(3.728)	(-2.555)	
L.CashHold		-0.3796***			-0.3908***			-0.3449***			-0.2875***	
		(-28.404)			(-32.680)			(-12.174)			(-14.404)	
L.Debt	-0.0784***			-0.0821***			-0.1875***			-0.1163***		
	(-9.973)			(-11.053)			(-8.646)			(-7.447)		
L.Invest			0.2004***			0.1374***			0.2571***			0.5363***
			(22.487)			(20.108)			(13.232)			(33.367)
Q	0.0011**	0.0041***	0.0014***	0.0003	0.0069***	0.0021***	0.0042***	0.0005	0.0010***	0.0008	-0.0000	0.0006***
	(1.978)	(4.128)	(6.528)	(0.479)	(6.497)	(11.608)	(2.972)	(0.405)	(2.767)	(0.702)	(-0.009)	(3.461)
Size	0.0102***	0.0160***	-0.0007	0.0035**	0.0334***	0.0002	0.0145***	0.0030	-0.0026**	0.0129***	-0.0056*	-0.0023***
	(6.746)	(5.114)	(-1.063)	(2.424)	(13.874)	(0.531)	(3.289)	(0.723)	(-2.181)	(3.761)	(-1.683)	(-3.977)
Constant	-0.0094	-0.0511	0.0267	0.0804	-0.0878	0.0061	-0.1241***	0.0018	0.0488***	-0.1283***	0.0924***	0.0488***
	(-0.196)	(-0.626)	(1.457)	(1.231)	(-0.811)	(0.285)	(-2.642)	(0.039)	(3.939)	(-3.506)	(2.612)	(8.152)
N	21,656	21,656	21,656	20,271	20,271	20,271	3,162	3,162	3,162	4,108	4,108	4,108

5 Additional results

5.1 Tangibility of assets and cash flow volatility

The analyses so far consider only the most direct influencing factors of joint investment, financing and liquidity decisions in firms. The earlier literature has, however, identified additional drivers of cash flow sensitivities. According to Almeida and Campello (2007), asset tangibility should affect the investment-cash flow sensitivity of constrained firms via the ability to increase their debt capacity. Bates, Kahle, and Stulz (2009) show that cash flow volatility plays an additional role as a risk management motive for cash holdings. In the following, we will examine whether accounting for these two variables in our empirical model delivers new results.[3]

From the results presented in Tables 7 to 9, we see that *Intang*, the ratio of intangible to total assets, has a significantly negative effect on investment only for constrained firms with high hedging needs, no significant effect on net debt issues but a significantly negative effect on the cash stocks of all groups of firms. The first of these effects supports the earlier findings by Almeida and Campello (2007): A lower ratio of intangible to total assets (and hence, by implication, a higher ratio of tangible assets) increases investments for constrained firms. Even though we do not find that firms indeed raise more debt with a lower intangibles ratio, it cannot be excluded that these firms nevertheless improve their potential debt capacity by investing in more tangible assets.

The volatility of cash flows affects investments for firms with low hedging needs: It increases the investment of constrained firms but decreases the investment of unconstrained firms. Apart from this, there are no further direct effects. This is an interesting observation as it shows again that considering joint investment, financing and liquidity decisions delivers different results than looking at the individual decisions in isolation. Nevertheless, our results and the earlier findings by Bates, Kahle, and Stulz (2009) are not contradictory: We observe that constrained firms (with low hedging needs) raise their investments with growing cash flow volatility. At the same time, we find that constrained firms increase their investments along with cash holdings when disregarding the effect of cash flow volatility (Table 3). Hence, when studying corporate decisions in isolation it is easily conceivable that an increasing effect of cash flow volatility on cash stocks á la Bates, Kahle, and Stulz (2009) may be observed.

[3] It should be noted that information on intangible assets is not available for all firms in our sample. Including this variable in the empirical models therefore strongly reduces the number of observations.

Table 7: Choice of Investment, Accounting for Asset Tangibility and Cash Flow Volatility

This table displays 3SLS results (including firm and quarter fixed effects) of the empirical model for investments (see Eqs. (1) to (3)). The endogenous dependent variable is Invest. Financial constraints are determined via the firm's payout ratio. Hedging needs are measured based on the correlation between a firm's cash flow and industry-level R&D expenses. All data are from the quarterly COMPUSTAT industrial tapes between January 1980 and September 2014. Investment, debt and cash models are jointly estimated. t-statistics are in parentheses. $*$, $**$ and $***$ indicate statistical significance at the 10-, 5- and 1-percent level, respectively.

	Constrained		Unconstrained	
	Hedging Needs High	Hedging Needs Low	Hedging Needs High	Hedging Needs Low
CashFlow	0.0008	-0.0101	0.0040	0.0165*
	(0.148)	(-1.403)	(0.347)	(1.809)
ΔCashHold	0.0038	0.0040	0.0086	0.0156***
	(0.721)	(0.576)	(1.071)	(3.074)
ΔDebt	0.0297	0.0137	0.0594***	0.0355***
	(0.492)	(0.214)	(2.842)	(3.350)
Intang	-0.0124***	-0.0052	-0.0076	-0.0009
	(-2.930)	(-0.907)	(-1.406)	(-0.290)
CFVol	0.0001	0.0003***	-0.0001	-0.0484***
	(0.104)	(2.817)	(-0.457)	(-3.591)
Q	0.0017***	0.0012***	0.0010***	0.0011***
	(5.939)	(3.796)	(3.133)	(5.749)
Size	0.0005	0.0006	0.0015	-0.0036***
	(0.414)	(0.130)	(0.992)	(-3.653)
L.Invest	0.2067***	0.0640***	0.0759***	0.3731***
	(14.477)	(4.275)	(5.399)	(29.983)
Constant	-0.0251	-0.0061	0.0251	0.0594***
	(-0.660)	(-0.157)	(0.947)	(3.549)
N	9,242	7,344	5,476	5,755

However, including these two variables (*Intang* and *CFVol*) into our empirical model partly takes away significant effects exerted by other variables. In this respect, we find that investment-cash flow sensitivities vanish almost completely as does the effect of cash holdings and debt changes on investment for constrained firms (Table 7). With regard to net debt issues we still observe a negative cash flow sensitivity for firms with high hedging needs but no longer for firms with low hedging needs (Table 8). Interestingly, the cash flow sensitivity of net debt issues becomes much stronger for constrained firms with high hedging needs. Constrained firms with low hedging needs, in contrast, even start to raise their debt levels with increasing cash flows. At the same time, this group of firms reduces their cash stocks with increasing cash flows after accounting for intangible assets and cash flow volatility (Table 9). Paralleling the observation for debt issues, we find that the cash flow sensitivities of cash holdings also become stronger for firms with high hedging

Table 8: Choice of Debt, Accounting for Asset Tangibility and Cash Flow Volatility

This table displays 3SLS results (including firm and quarter fixed effects) of the empirical model for debt (see Eqs. (1) to (3)). The endogenous dependent variable is ΔDebt. Financial constraints are determined via the firm's payout ratio. Hedging needs are measured based on the correlation between a firm's cash flow and industry-level R&D expenses. All data are from the quarterly COMPUSTAT industrial tapes between January 1980 and September 2014. Investment, debt and cash models are jointly estimated. t-statistics are in parentheses. $*, **$ and $***$ indicate statistical significance at the 10-, 5- and 1-percent level, respectively.

	Constrained		Unconstrained	
	Hedging Needs High	Hedging Needs Low	Hedging Needs High	Hedging Needs Low
CashFlow	-0.0680***	0.1022***	-0.0962**	-0.0121
	(-5.652)	(4.009)	(-2.161)	(-0.196)
ΔCashHold	0.0414***	0.0521**	0.0794**	-0.0201
	(2.908)	(1.985)	(2.539)	(-0.593)
Invest	0.7317***	1.7665*	0.3908	0.2993
	(4.562)	(1.948)	(0.544)	(1.362)
Intang	0.0159	0.0359	0.0287	0.0043
	(1.193)	(1.332)	(1.298)	(0.206)
CFVol	0.0020	-0.0004	-0.0005	-0.0008
	(0.608)	(-0.800)	(-0.878)	(-0.009)
Q	0.0005	-0.0007	0.0048***	-0.0020
	(0.608)	(-0.416)	(3.242)	(-1.466)
Size	0.0044	-0.0355*	0.0314***	0.0436***
	(1.125)	(-1.876)	(5.091)	(6.741)
L.Debt	-0.0685***	-0.0715***	-0.1985***	-0.2573***
	(-5.212)	(-3.386)	(-10.358)	(-13.827)
Constant	-0.0500	0.1543	-0.1297	0.2627
	(-0.425)	(0.894)	(-0.455)	(1.480)
N	9,242	7,344	5,476	5,755

needs with the strongest effect for constrained firms.

Accounting for asset tangibility and cash flow volatility hence pronounces the differences between firms with low and high hedging needs. The latter show much stronger cash flow sensitivities for net debt issues and changes in cash holdings than before. For investment-cash flow sensitivities, in contrast, significance is almost lost.

5.2 Crisis effects

The financial crisis 2007/08 has allegedly led to severe and lasting changes in firms' operations and strategies (Kahle and Stulz (2013)). Not only did corporate borrowing and capital expenditures fall sharply, but the shock to financial markets also disrupted established financing practices and relationships. Examining the

Table 9: Choice of Cash, Accounting for Asset Tangibility and Cash Flow Volatility

This table displays 3SLS results (including firm and quarter fixed effects) of the empirical model for cash (see Eqs. (1) to (3)). The endogenous dependent variable is ΔCashHold. Financial constraints are determined via the firm's payout ratio. Hedging needs are measured based on the correlation between a firm's cash flow and industry-level R&D expenses. All data are from the quarterly COMPUSTAT industrial tapes between January 1980 and September 2014. Investment, debt and cash models are jointly estimated. t-statistics are in parentheses. $*$, $**$ and $***$ indicate statistical significance at the 10-, 5- and 1-percent level, respectively.

	Constrained		Unconstrained	
	Hedging Needs High	Hedging Needs Low	Hedging Needs High	Hedging Needs Low
CashFlow	0.2174***	-0.6891**	0.6754***	0.4756***
	(2.997)	(-1.968)	(10.183)	(6.410)
ΔDebt	1.3150	0.4325	0.4623***	0.0231
	(1.633)	(0.122)	(3.038)	(0.254)
Invest	-1.9623**	-16.2653	-3.3167***	-1.4377***
	(-2.145)	(-1.393)	(-2.728)	(-4.993)
Intang	-0.6745***	-0.9118***	-0.5765***	-0.5037***
	(-10.512)	(-3.009)	(-13.964)	(-18.441)
CFVol	-0.0180	0.0050	0.0007	0.0648
	(-1.261)	(0.880)	(0.808)	(0.558)
Q	0.0099**	0.0121	0.0030	0.0031*
	(2.463)	(0.543)	(1.270)	(1.800)
Size	0.1987***	0.7304***	0.0579***	0.0612***
	(12.382)	(11.432)	(5.815)	(7.380)
L.CashHold	-0.7242***	-0.6688***	-0.6157***	-0.5441***
	(-14.064)	(-2.781)	(-19.472)	(-23.448)
Constant	0.2186	-3.6527**	-0.2677	-0.4731***
	(0.422)	(-2.072)	(-1.559)	(-3.327)
N	9,242	7,344	5,476	5,755

changes to the joint investment, financing and liquidity choices of corporations in the aftermath of the crisis is not only interesting in its own right but also helpful in order to design effective policies to stimulate corporate investment and, eventually, economic growth. In the following, we will study the empirical model described by Equations (1) to (3) on data following the height of the financial crisis in Q2 2007.

As can be seen from Table 10, in the quarters after the financial crisis investment-cash flow sensitivities have been strongly reduced. The only significant sensitivity is found for unconstrained firms with low hedging needs. Constrained firms no longer show an association between net debt issues and capital expenditures. Only constrained firms with high hedging needs appear to resort to their cash piles for funding investments. It is also interesting to note that constrained firms with high hedging needs show the strongest effect of investment opportunities on investments after the crisis.

Table 10: Choice of Investment, Q3 2007 to Q3 2014

This table displays 3SLS results (including firm and quarter fixed effects) of the empirical model for investment (see Eqs. (1) to (3)). The endogenous dependent variable is Invest. Financial constraints are determined via the firm's payout ratio. Hedging needs are measured based on the correlation between a firm's cash flow and industry-level R&D expenses. All data are from the quarterly COMPUSTAT industrial tapes between Q3 2007 and Q3 2014. Investment, debt and cash models are jointly estimated. t-statistics are in parentheses. $*, **$ and $***$ indicate statistical significance at the 10-, 5- and 1-percent level, respectively.

	Constrained		Unconstrained	
	Hedging Needs High	Hedging Needs Low	Hedging Needs High	Hedging Needs Low
CashFlow	0.0008	-0.0044	-0.0006	0.0244*
	(0.151)	(-0.462)	(-0.046)	(1.894)
ΔCashHold	-0.0191**	-0.0171	0.0171*	0.0140**
	(-2.496)	(-1.615)	(1.936)	(2.101)
ΔDebt	0.0617	0.0824	0.0216	0.0392***
	(1.222)	(1.165)	(0.935)	(3.107)
Q	0.0024***	0.0005	0.0014***	0.0007**
	(5.103)	(0.911)	(3.154)	(2.277)
Size	0.0063**	0.0078**	0.0010	-0.0030*
	(2.380)	(2.243)	(0.373)	(-1.784)
L.Invest	0.2196***	-0.0173	0.0605***	0.3942***
	(12.861)	(-0.994)	(3.143)	(23.297)
Constant	-0.0087	-0.0223	-0.0011	0.0539***
	(-0.541)	(-1.048)	(-0.041)	(3.190)
N	4,242	3,219	3,034	3,208

According to Table 11, firms with high hedging needs still reduce their debt levels with increasing cash flows after the financial crisis, but firms with low hedging needs no longer do so. For unconstrained firms the significant association between investments and net debt issues and also between changes in cash holdings and net debt issues vanishes completely after the crisis. However, unconstrained firms with high hedging needs still show the strong positive effect of investment opportunities on changes in debt levels.

With respect to liquidity choices, Table 12 shows that unconstrained firms still save cash out of cash flows, but constrained firms no longer do so after the financial crisis. As has already been seen from Table 10, the association between cash holdings and investment no longer holds for constrained firms. Nevertheless, we still observe that constrained firms with high hedging needs increase their cash stocks along with investment opportunities.

Table 11: Choice of Debt, Q3 2007 to Q3 2014

This table displays 3SLS results (including firm and quarter fixed effects) of the empirical model for debt (see Eqs. (1) to (3)). The endogenous dependent variable is ΔDebt. Financial constraints are determined via the firm's payout ratio. Hedging needs are measured based on the correlation between a firm's cash flow and industry-level R&D expenses. All data are from the quarterly COMPUSTAT industrial tapes between Q3 2007 and Q3 2014. Investment, debt and cash models are jointly estimated. t-statistics are in parentheses. $*, **$ and $***$ indicate statistical significance at the 10-, 5- and 1-percent level, respectively.

	Constrained		Unconstrained	
	Hedging Needs High	Hedging Needs Low	Hedging Needs High	Hedging Needs Low
CashFlow	-0.0294**	-0.0371	-0.1915***	-0.0145
	(-2.031)	(-1.107)	(-3.413)	(-0.161)
ΔCashHold	0.0777***	0.0659*	0.0554	-0.0301
	(3.736)	(1.745)	(1.199)	(-0.645)
Invest	0.6028***	-0.7524	0.4897	0.2865
	(3.025)	(-0.256)	(0.354)	(0.976)
Q	-0.0026*	0.0018	0.0079***	-0.0008
	(-1.780)	(0.777)	(2.686)	(-0.401)
Size	-0.0038	-0.0130	0.0672***	0.0858***
	(-0.482)	(-0.662)	(6.358)	(8.382)
L.Debt	-0.1529***	-0.1672***	-0.2653***	-0.3417***
	(-6.547)	(-3.448)	(-9.406)	(-11.154)
Constant	-0.0016	0.0497	-0.6298***	-0.7391***
	(-0.033)	(0.679)	(-6.138)	(-7.157)
N	4,242	3,219	3,034	3,208

6 Conclusion

Accounting explicitly for the simultaneity of investment, debt and liquidity decisions portrays a more nuanced picture than earlier studies on isolated corporate choices delivered. We find that not only financial constraints trigger different strategies for preserving financial flexibility but so does the need to hedge against future income shortfalls.

We observe large cash flow sensitivities of investment, net debt issues and changes in cash stocks for unconstrained firms. In essence, these firms' corporate decisions are most strongly impacted by shocks to their cash flows. Among constrained firms, cash flow sensitivities are larger for companies with high hedging needs. Though the sensitivity coefficients are much smaller than for unconstrained firms, it should be taken into consideration that cash flow levels are also much lower for constrained companies.

Accounting for asset tangibility and cash flow volatility erodes most of the investment-cash flow sensitivities but emphasizes the differential effects of hedging needs on the cash flow sensitivities of net debt

Table 12: Choice of Cash, Q3 2007 to Q3 2014

This table displays 3SLS results (including firm and quarter fixed effects) of the empirical model for cash (see Eqs. (1) to (3)). The endogenous dependent variable is ΔCashHold. Financial constraints are determined via the firm's payout ratio. Hedging needs are measured based on the correlation between a firm's cash flow and industry-level R&D expenses. All data are from the quarterly COMPUSTAT industrial tapes between Q3 2007 and Q3 2014. Investment, debt and cash models are jointly estimated. t-statistics are in parentheses. $*, **$ and $***$ indicate statistical significance at the 10-, 5- and 1-percent level, respectively.

	Constrained		Unconstrained	
	Hedging Needs High	Hedging Needs Low	Hedging Needs High	Hedging Needs Low
CashFlow	-0.0005	0.3403	0.7038***	0.5965***
	(-0.008)	(0.783)	(7.868)	(5.133)
ΔDebt	0.7043	-1.5133	0.2708	0.1332
	(1.028)	(-0.378)	(1.563)	(1.103)
Invest	-1.3030	29.9306	-2.1765	-0.8943**
	(-1.280)	(0.642)	(-0.924)	(-2.191)
Q	0.0247***	-0.0098	0.0037	0.0110***
	(3.623)	(-0.364)	(0.757)	(3.860)
Size	0.2815***	0.1312	0.0391**	-0.0310*
	(10.260)	(0.714)	(2.005)	(-1.897)
L.CashHold	-0.8566***	-1.1760*	-0.7305***	-0.5613***
	(-9.067)	(-1.730)	(-13.444)	(-15.980)
Constant	-0.2283	-0.8503	-0.2832	0.3018*
	(-1.048)	(-1.388)	(-1.457)	(1.833)
N	4,242	3,219	3,034	3,208

issues and changes in cash holdings. Essentially, we observe that firms with high hedging needs display a stronger dependence on cash flow shocks when controlling for intangible assets and riskiness in cash flows. This is an interesting observation as most of the earlier literature remarked on the impact of the additional variables on firms' investment behavior. What we find, in contrast, is that the underlying force is driven by the reaction of cash holdings and debt levels rather than capital expenditures.

A persistent result in our analyses is the differential way in which firms with high hedging needs try to preserve their ability to finance future investment opportunities. Both constrained and unconstrained firms with high hedging needs lack the current internal means to finance upcoming investment possibilities. But they react in completely different ways to this challenge: Constrained firms with high hedging needs increase their cash holdings (by both saving cash flows but also by drawing down more debt), while unconstrained firms with high hedging needs raise their net debt issues. These two different strategies are shown to be robust to the consideration of additional influencing factors and are also observed in the aftermath of the

financial crisis in 2007/08. They hence seem to be a fundamental pillar of corporations' joint investment, debt financing and liquidity decisions.

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