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Cash holding, trade credit and access to short-term bank finance

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A B S T R A C T

Since 1988, cash holding of the UK companies has increased from 10.6% to 16.4% of total assets. To explain this increase, we develop a panel vector autoregression and analyse the dynamics between cash holding and its closest substitutes, trade credit and short-term bank finance. Impulse response functions confirm the signalling theory, as trade credit facilitates access to bank finance. Firms experiencing liquidity shocks resort to cash or trade credit but not to bank finance. Cash holding improves access to trade credit. Additional cash and trade credit trigger a slowdown of the cash conversion cycle explained by agency theory. Cash-rich firms have accumulated more cash than predicted because of an unexpected decline in short-term debt, stressing the role of banks in explaining the increase in cash holding.

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1. Introduction

Bates, Kahle, and Stulz (2009) show that average cash ratios, defined as cash and cash equivalents relative to total assets, of the US firms increased from 10.5% to 23.2% in the period from 1980 to 2006. We analyse the UK listed companies in the period from 1988 to 2008 and find an increase in average cash ratios from 10.6% to 16.4%. In contrast, Ferreira and Vilela (2004: 303) state that "it is not possible to identify any clear trend" in cash holding in EMU countries between 1987 and 2000. Yet their investigation period does not include the Dot-com bubble or the recent financial crisis. The literature on cash holding focuses on four motives determining the demand for cash: transaction, precaution, investment opportunities, and self-interest (Graham & Harvey, 2001; Harford, 1999; Harford, Mansi, & Maxwell, 2008; Keynes, 1936; Myers, 1977; Myers & Majluf, 1984). The motive driven view understates the importance of a supply-side explanation. Cash holding might increase due to a lack of alternative funding. The main characteristic of cash is its flexibility, as it is available instantaneously (Ang & Smedema, 2011). The closest substitutes in terms of instantaneous access are trade credit and short-term bank finance. Of course, reducing dividends or selling assets can provide liquidity — but these

options are not instantaneous and costly due to signalling effects and transaction costs (Keynes, 1936; Opler, Pinkowitz, Stulz, & Williamson, 1999).

This paper considers the demand and supply-side explanations of cash holding by analysing the dynamics between cash holding and its closest substitutes, trade credit and short-term bank finance. To capture a firm's short-term liquidity need, we determine the cash conversion cycle (CCC). We develop a panel vector autoregression (VAR) accounting for the complex interrelationships between cash holding, trade credit, short-term bank finance and liquidity needs. This novel method leads to three contributions: (1) distinguishing between the demand and supply-side of liquidity, (2) extending the dynamic model of cash holding, and (3) analysing the mismatch of expectations concerning access to short-term bank finance.

The literature on cash holding mainly relies on demand-side explanations (Opler et al., 1999); however, Bates et al. (2009) contend that there was no shift in the demand for cash that could explain the recent increase in cash holding. They argue that firm characteristics changed, increasing cash holding due to riskier cash flows, higher R&D intensity and lower working capital requirements (i.e. lower inventory and accounts receivable). Bates et al. (2009) do not consider the role of trade credit granted by suppliers and short-term bank finance. Both sources of short-term funding have declined sharply in the UK during the investigation period. Hence, the supply-side is essential in understanding the recent increase in cash holding. After specifying a panel

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VAR, we determine impulse response functions to differentiate between demand and supply-side effects. This provides insights into the dynamic relationships between cash holding, firms' liquidity needs, trade credit and short-term bank finance.

This paper extends the dynamic model of cash holding by incorporating additional lags based on information criteria (Opler et al., 1999; Ozkan, Ozkan, & N., 2004). Static models are biased because past cash holding affects current cash holding. Apart from improving the econometric validity of the model, we gain insights into the dynamic relationship between the demand and supply of liquidity. In particular, we specify a panel vector autoregression (VAR) with four dependent variables: cash holding, the CCC to capture a firm's liquidity need, trade credit and short-term bank finance. The literature on trade credit applies panel VARs to aggregated data (Nilsen, 2002). In contrast, our panel VAR refers to the firm-level and deals with the inherent endogeneity and firm heterogeneity by applying a system GMM estimation (Arellano & Bond, 1991; Ozkan et al., 2004). Granger causality tests show that the four variables are endogenous. Consequently, a single-equation approach suffers from an endogeneity bias (Opler et al., 1999; Ozkan et al., 2004). In particular, the liquidity need measured by the CCC is endogenous; hence, using the CCC as an explanatory variable without a time lag violates weak exogeneity (Deloof, 2001).

In spite of delivering accurate one-step ahead forecasts for the average firm, the model understates the rapid accumulation of cash by cash-rich firms defined as belonging to the 75-percentile in 1988. Hence, we impose a liquidity constraint, which states that cash holding has to be sufficient to cover net working capital given expected access to external finance. We show that cash-rich firms suffer from lower than expected access to external finance. Accordingly, the pronounced increase in cash holding can be explained by a mismatch of expectations, a novel finding.

This paper has the following structure: section two reviews the literature on the relationship between cash holding, trade credit, access to short-term bank finance and the CCC; section three discusses the dataset and construction of variables; section four introduces the panel VAR and shows our findings followed by robustness checks and concluding remarks.

2. Literature review

2.1. The motive-driven view of cash holding

Empirical studies use net working capital, which includes trade credit, as an explanatory variable (e.g. Ferreira & Vilela, 2004; Opler et al., 1999). Yet, the literature does not consider the role of trade credit as a source of external funding explicitly. In contrast, the literature on the relationship between trade credit and access to bank finance discussed in the next section largely ignores the role of cash holding. Consequently, it seems to be essential to combine both strands of the literature and analyse the demand and supply-side of liquidity. The literature on cash holding identifies the following theories: transaction cost theory, information asymmetry between debt and equity holders, and agency costs due to a conflict of interest between shareholders and managers.

Transaction cost theory argues that transaction costs due to converting cash substitutes into cash justify cash holding (Keynes, 1936; Miller & Orr, 1966; Tobin, 1956). There are several hypotheses related to the transaction cost theory highlighted by Opler et al. (1999). Some of these hypotheses refer to long-term decision making not relevant for meeting short-term liquidity needs due to the lack of instantaneous access. For instance, the asset sales of diversified companies and the reduction of dividend payments cannot substitute cash holding in the short-term (Ang & Smedema, 2011). Information asymmetry between debt and equity holders could explain cash holding. Myers and Majluf (1984) contend that securities might be undervalued by outsiders due to the lack of access to information. R&D expenses serve as a proxy for projects with a high degree of information asymmetry. As we focus on the instantaneous availability of cash and its closest substitutes, R&D expenses and some forms of external finance (e.g. equity issues) are not a relevant option to meet short-term

Table 1
Descriptive statistics.

Cash holding (*cash*) is defined as cash and cash equivalents relative to total assets. Short-term bank finance (*S*) is the ratio of short-term bank finance and total assets. Trade credit (*tc*) refers to the ratio of accounts payable and total assets. Liquidity (*liquid*) is measured by the cash conversion cycle CCC (see Eq. (1)). Growth refers to the annual growth rate in sales. The return on assets (*ROA*) is defined as earnings before interest and taxes divided by adjusted total assets (total assets excluding cash). Pre-tax cost of debt (*i*) is determined based on interest expenses and debt. Firm size (*size*) refers to the natural logarithm of total assets. The measure for cash flow volatility (*risk*) is the variation coefficient of cash flows in a three-year window. Bank finance relative to total debt determines the variable bank. The interest coverage (*cover*) is defined as earning before interest and taxes relative to interest expenses. Financial leverage (*L*) refers to total debt relative to total assets. Panel C summarises the components of the CCC (see Eq. (1)), namely inventory relative to cost of goods sold (*inv_cogs*), accounts receivable relative to revenues (*ar_rev*) and accounts payable relative to cost of goods sold (*ap_cogs*). Panel D shows the components of profitability, the cost–income ratio (*k*) and capital turnover (*T*). The table shows the number of observations (Obs), the mean, standard deviation (Std. Dev.), minimum, maximum and the change in percent based on the median and mean from 1988 to 2008.

| Variable	Obs	Mean	Std. Dev.	Min	Max	Median change	Average change
Panel A: endogenous variables							
cash	14,073	0.158	0.154	0.006	0.481	71.0%	54.7%
S	13,801	0.228	0.124	0.062	0.453	−23.6%	−18.4%
tc	13,803	0.118	0.082	0.019	0.271	−48.7%	−34.8%
liquid	13,105	0.212	0.146	0.017	0.497	−25.3%	−15.6%
Panel B: control variables							
growth	12,511	0.160	0.269	−0.184	0.732	−15.3%	−13.4%
ROA	13,977	−0.013	0.263	−0.643	0.243	−66.7%	−133.1%
i	12,116	0.101	0.065	0.032	0.251	−28.0%	−20.3%
size	14,631	10.721	1.966	7.877	14.028	−0.8%	−1.6%
risk	14,515	0.930	0.931	0.136	3.077	139.2%	106.5%
bank	6518	0.255	0.324	0.001	0.880	−72.2%	−13.1%
cover	12,776	7.086	22.219	−32.000	53.329	−68.6%	−73.5%
L	14,622	0.156	0.143	0.000	0.417	0.0%	10.6%
Panel C: components of the cash conversion cycle							
inv_cogs	14,444	0.090	0.088	0.000	0.249	−85.1%	−55.3%
ar_rev	13,730	0.210	0.116	0.057	0.450	1.5%	10.6%
ap_cogs	13,714	0.107	0.055	0.034	0.208	−28.7%	−19.5%
Panel D: components of profitability (ROA)							
k	13,704	1.024	0.272	0.780	1.715	7.9%	21.3%
T	13,490	2.063	1.474	0.192	4.785	−53.4%	−40.3%
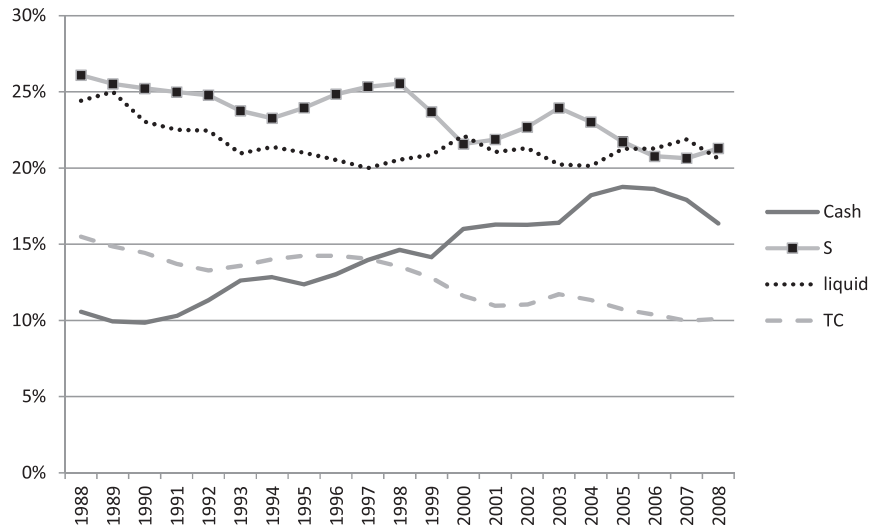
Fig. 1. Endogenous time series based on sample averages. The figure shows the average value of cash holding (*cash*), short-term bank finance (*S*), liquidity need (*liquid*) and trade credit (*tc*) of the whole sample. All variables are in percent of total assets.

liquidity needs. Finally, agency costs due to conflicts of interest between managers and shareholders are of a long-term nature such as empire building through acquisitions (Jensen, 1986). However, there might be a short-term equivalent, namely the incentive to improve working capital management, which this paper discusses.

The empirical evidence for transaction costs and information asymmetry and the related motives of transaction, precaution, and investment opportunities stress the predominant role of transactions in explaining cash holding (Beltz & Frank, 1996; Deloof, 2001; John, 1993). D'Mello, Krishnaswami, and Larkin (2008) show that firms with easy internal financing hold little cash, whereas firms with high growth opportunities and volatile cash flows hold more cash. Based on the theoretical considerations, costs of holding cash (opportunity costs), cost of external finance, volatility of cash flows, firm size and growth opportunities determine cash holding. Holding cash is mainly driven by the need to execute transactions — but prevention could be relevant in the case of small firms in unstable environments. Opler et al. (1999) analyse the determinants of cash holding in the US and uncover that cash holding is negatively associated with firm size and positively associated with investment opportunities, risk and the difficulty in obtaining external finance measured by high financial leverage.

2.2. Access to short-term bank finance and trade credit

The literature on trade credit and short-term bank finance falls into two main categories: (1) the substitution hypothesis pioneered by Meltzer (1960) and (2) the complementary view based on signalling theory and the underlying information asymmetry between suppliers and banks (Bias & Gollier, 1997; Jain, 2001). Firms with access to bank finance need less trade credit, which is usually more expensive; thus, there is a substitution effect (Bias & Gollier, 1997). Yet, the literature contends that substitution is the direct effect, whereas trade credit has an indirect signalling effect. We test the relationship between trade credit and short-term bank finance, which could confirm the substitution effect or the signalling theory. In addition, Petersen and Rajan (1997) emphasise that there is a positive correlation between the firm's willingness to provide trade credit and access to short-term finance. Amid the financial crisis, this effect could be of importance, as firms might face pressure from two sides: restricted access to bank finance due to the credit crunch and less trade credit granted by suppliers, which in turn suffer from a lack of short-term liquidity.

2.3. The need for liquidity based on the cash conversion cycle (CCC)

The cash holding literature has tested the transaction motive using sales as a proxy, which should reflect the firm's business activities and associated transaction needs. Using sales as a proxy is problematic, since sales and firm size are correlated. Hence, it is difficult to distinguish between size effects and transaction needs. For instance, firms with low accounts receivable and high sales do not need much cash, as customers tend to pay immediately (e.g. retailers have high sales and low accounts receivable, which results in negative net working capital). Accordingly, to determine the liquidity needs of a firm, we follow Deloof (2001) and calculate the CCC of each firm. The CCC, which goes back to Gitman (1974), is a dynamic measure of liquidity and better than static measures such as net working capital relative to total assets. Most studies of the CCC focus on its impact on profitability measures confirming a negative relationship (Wang, 2002). So a smaller CCC improves profitability, which in turn enhances shareholder value.

3. The method of sampling and construction of variables

We collected annual data from Datastream on all companies listed on the London Stock Exchange (Main Market) in the period from 1988 to 2008. To cross-check accounting data, we used annual reports. After removing regulated industries such as utilities and financial institutions, the sample consists of 1343 companies. Due to missing values, the maximum number of firm-year observations is 14631. As the number of listed companies changed during the investigation period, the robustness check considers a potential survivorship bias. The four endogenous variables refer to cash ratios defined as cash and cash equivalents relative to total assets (*cash*), trade credit granted by suppliers defined as accounts payable relative to total assets (*tc*), short-term bank finance relative to total assets (*S*), and the firm's liquidity need based on the CCC (*liquid*). Eq. (1) defines the CCC, which follows Deloof (2001).

$$\text{liquid}_{it} = \frac{INV_{it}}{COGS_{it}} + \frac{AR_{it}}{REV_{it}} - \frac{AP_{it}}{COGS_{it}}. \tag{1}$$

In line with prior research, we included sales growth (*growth*), firm size defined as the natural logarithm of total assets (*size*), and profitability measured by the return on adjusted total assets (*ROA*). To remove the effect of non-operating assets including excess cash, we adjust total assets to reflect only net property, plant and equipment and net

Table 2
Annual averages.
The table provides annual averages for selected variables.

Year	growth	ROA	i	size	risk	bank	cover	L	inv_cogs	ar_rev	ap_cogs	k	T
1988	–	0.154	0.118	10.950	0.418	0.321	17.334	0.142	0.161	0.198	0.128	0.880	2.803
1989	0.231	0.138	0.124	11.028	0.505	0.246	13.688	0.168	0.152	0.205	0.125	0.894	2.633
1990	0.129	0.126	0.145	11.149	0.614	0.273	9.796	0.177	0.144	0.191	0.119	0.910	2.565
1991	0.040	0.092	0.142	11.136	0.624	0.313	8.518	0.182	0.136	0.187	0.110	0.935	2.479
1992	0.047	0.081	0.131	11.134	0.670	0.268	9.005	0.185	0.135	0.190	0.109	0.939	2.407
1993	0.101	0.083	0.121	11.206	0.662	0.265	9.881	0.165	0.126	0.187	0.113	0.938	2.425
1994	0.125	0.093	0.104	11.261	0.672	0.239	12.035	0.154	0.126	0.195	0.118	0.940	2.407
1995	0.177	0.096	0.103	11.324	0.620	0.222	12.135	0.158	0.124	0.194	0.117	0.937	2.500
1996	0.155	0.090	0.109	10.915	0.696	0.213	11.550	0.154	0.112	0.194	0.114	0.958	2.550
1997	0.134	0.083	0.108	10.844	0.768	0.236	12.070	0.152	0.108	0.197	0.115	0.973	2.582
1998	0.130	0.039	0.100	10.887	0.823	0.236	11.129	0.167	0.102	0.202	0.111	0.986	2.438
1999	0.136	0.023	0.101	10.869	0.850	0.234	9.035	0.169	0.098	0.207	0.110	0.996	2.177
2000	0.184	−0.029	0.100	10.842	0.953	0.239	6.894	0.155	0.089	0.222	0.110	1.044	1.948
2001	0.179	−0.072	0.100	10.752	0.917	0.254	2.505	0.157	0.082	0.212	0.102	1.082	1.917
2002	0.111	−0.098	0.091	10.532	0.867	0.246	1.224	0.164	0.077	0.211	0.096	1.100	1.938
2003	0.131	−0.089	0.088	10.383	0.850	0.252	3.085	0.165	0.071	0.209	0.097	1.087	2.025
2004	0.163	−0.055	0.091	10.348	0.854	0.260	6.462	0.152	0.071	0.209	0.103	1.048	2.042
2005	0.189	−0.057	0.093	10.395	0.816	0.265	6.145	0.142	0.069	0.221	0.105	1.054	1.907
2006	0.207	−0.051	0.092	10.490	0.868	0.268	5.172	0.142	0.069	0.224	0.106	1.060	1.803
2007	0.197	−0.053	0.095	10.632	0.864	0.269	5.286	0.147	0.068	0.227	0.104	1.067	1.700
2008	0.200	−0.051	0.094	10.774	0.863	0.279	4.591	0.157	0.072	0.219	0.103	1.067	1.672
Total	0.160	−0.013	0.101	10.721	0.805	0.255	7.086	0.156	0.090	0.210	0.107	1.024	2.063

operating working capital. Pre-tax cost of debt (i) accounts for the cost of external debt finance, and it is also used as a proxy for the opportunity cost of cash holding, as cash substitutes external debt finance (Opler et al., 1999). The following proxies incorporate firms' financial risk: financial leverage defined as total debt relative to total assets (L) and interest coverage defined as earnings before interest and taxes ($EBIT$) relative to interest expenses ($cover$). Some studies include the ratio of bank finance to total debt ($bank$) to evaluate the monitoring role of banks, which is also common in the trade credit literature (Gama, Mateus, & Teixeira, 2008). We include a measure for the uncertainty of cash flows defined as the variation coefficient of EBIT in a three-year window ($risk$). The definition of cash flow risk differs from Bates et al. (2009), for they refer to the mean of the standard deviation of cash flows in an industry based on 2-digit SIC codes. Their measure captures the industry-specific cash flow uncertainty but does not reflect idiosyncratic risk. Moreover, variation coefficients are robust if means differ across firms. In addition, we determine the variables needed to calculate the CCC, namely inventory relative to cost of goods sold (inv_cogs), accounts receivable relative to revenues (ar_rev) and accounts payable relative to cost of goods sold (ap_cogs). To illustrate the underlying drivers of firms' profitability, the descriptive statistics also report the cost–income ratio defined as operating costs relative to operating income (k) and capital turnover defined as sales relative to total operating assets (T).

4. Empirical analysis

4.1. Descriptive findings

Table 1 provides descriptive statistics for the whole investigation period, and Fig. 1 depicts the time series of cash holding, the CCC, trade credit and short-term bank finance, revealing an increase in cash ratios from 10.6% to 16.4%. Apparently, cash holding increased long before the current financial crisis, reaching its peak in 2005. The need for liquidity determined by the CCC ($liquid$) exhibited an initial decline until 1993 but remained stable thereafter. Fig. 1 suggests that firms faced a constant liquidity need, whereas short-term bank finance (S) and trade credit (tc) exhibited a pronounced decline.

The question arises why the CCC has remained on a stable albeit high level in spite of various improvements in working capital management. Table 2 shows that inventory management improved substantially (inv_cogs) — maybe due to better production and transport technologies.

Accounts receivable relative to revenues (ar_rev) remained unchanged indicating that the UK firms had to provide trade credit to their customers to maintain sales and remain competitive. This finding supports Nadiri's (1969) model and shows that trade credit is part of the selling process. Trade credit provided by suppliers relative to cost of goods sold (ap_cogs) dropped; thus, the UK firms provided trade credit to their customers to sustain sales — but found it harder to get trade credit from their suppliers.

Diminished capital turnover (T) and higher cost–income ratios (k) reduce profitability (ROA). Firm size ($size$) remained on a similar level, whereas sales growth fluctuated due to business cycles. The importance of bank loans ($bank$) declined in line with control variables that affect access to external finance. Interest coverage ($cover$) worsened indicating a lack of earnings to cover interest expenses. The latter indicates that the UK companies might find it harder to get access to bank finance. The variation coefficient of cash flows ($risk$) increased over time. Cost of debt (i) fluctuated considerably in the investigation period — but compared to the 1980s cost of debt declined. In contrast to their US counterparts, the UK firms did not exhibit negative net debt in spite of more cash holding, as financial leverage (L) remained stable (Bates et al., 2009).

4.2. Panel vector autocorrelation (VAR)

To capture the dynamic relationships between cash holding, the CCC, trade credit and short-term bank finance, we specify a panel VAR with three lags based on the Bayesian Schwarz information criterion. We estimate the panel VAR with panel OLS, which ignores firm-specific effects, and system GMM based on the dynamic panel estimator developed by Arellano and Bond (1991) that considers firm-specific effects.[1] The model includes a set of lagged exogenous control variables. By lagging the control variables by one year, we ensure weak exogeneity, as the variables are predetermined. We include sales growth ($growth$), profitability (ROA), and firm size ($size$). To evaluate the firm's financial viability, the model considers cost of debt (i), interest coverage ($cover$), financial leverage (L), and uncertainty of cash flows ($risk$). The relative importance of bank finance ($bank$) serves as a measure for the firm's relationship with banks. The column vector $\mathbf{z_{it}}$

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[1] We cannot include firm-specific fixed effects, for dummy variables would be correlated with the lagged endogenous time series. Ozkan et al. (2004) address the related estimation issues and apply Arellano and Bond's (1991) GMM estimator.

Table 3

The panel VAR based on GMM and POLS.

Based on Eq. (2), panel VARs are estimated using short-term bank finance (S), cash holding (cash), liquidity needs (liquid) and trade credit (tc) as endogenous variables. The model also includes a set of exogenous variables, revenue growth (growth), interest coverage (cover), financial leverage (L), bank finance (bank), firm size (size), return on assets (ROA), volatility of cash flows (risk) and the pre-tax cost of debt (i). Stars (*, **, ***) indicates significance on the 90%, 95%, and 99% level of confidence respectively. The model is estimated using GMM and OLS. For the OLS estimates, adjusted R-squared is reported. For the GMM estimates, the Wald Chi-squared test is shown as well as tests for the first and second-order autocorrelation (Corr1, Corr2). The table also provides the p-values of the Sargan and Hansen tests.

	GMM estimation				Panel VAR using panel OLS			
	S	cash	liquid	tc	S	cash	liquid	tc
S_{t-1}	0.408***	0.005	−0.062***	0.016*	0.647***	0.033**	−0.022	0.016**
S_{t-2}	−0.006	−0.015	−0.006	−0.007	0.080***	0.016	0.001	−0.018**
S_{t-3}	−0.004	−0.020	−0.004	−0.003	0.109***	−0.011	−0.020	0.001
$cash_{t-1}$	0.001	0.412***	0.109***	0.060***	0.006	0.610***	0.035**	0.003
$cash_{t-2}$	0.000	0.021	0.006	0.028***	0.013	0.106***	−0.020	0.016**
$cash_{t-3}$	−0.004	−0.023	−0.015	−0.011	0.026**	0.070***	0.005	−0.019***
$liquid_{t-1}$	−0.053**	0.109***	0.219***	0.069***	−0.024	−0.002	0.571***	−0.007
$liquid_{t-2}$	−0.036*	0.016	−0.023	0.034***	−0.017	0.004	0.212***	0.005
$liquid_{t-3}$	0.023	0.010	−0.050***	0.007	0.020	0.004	0.116***	−0.004
tc_{t-1}	0.123***	0.250***	0.175***	0.502***	0.123***	−0.059*	−0.016	0.732***
tc_{t-2}	−0.052	0.022	0.090**	0.080***	−0.121***	−0.037	0.056	0.146***
tc	0.010	−0.005	−0.011	−0.002	0.015	0.074**	−0.031	0.047***
$growth_{t-1}$	−0.005	0.010	−0.004	−0.008***	−0.011**	−0.005	−0.029***	−0.008***
$cover_{t-1}$	−0.000**	−0.000***	0.000	−0.000***	−0.000***	0.000	0.000	−0.000***
L_{t-1}	−0.188***	0.104***	0.021	−0.011	−0.043***	−0.006	0.013	−0.022***
$bank_{t-1}$	0.006	−0.003	−0.008*	−0.001	−0.007**	0.000	−0.002	0.001
$size_{t-1}$	0.014***	−0.016***	−0.018***	0.002	0.000	−0.001*	−0.002***	0.000
ROA_{t-1}	0.012	0.035**	0.032**	0.021***	0.009	−0.032***	0.044***	0.001
$risk_{t-1}$	−0.001	−0.005**	0.003	−0.001	0.003**	0.000	0.000	0.000
i_{t-1}	−0.015	0.109***	0.071**	0.005	−0.013	0.093***	0.071***	−0.002
Constant	0.028	0.166***	0.349***	0.001	0.049***	0.024**	0.037***	0.014***
Adjusted R^2	–	–	–	–	0.637	0.584	0.759	0.844
Wald Ch^2	165.12***	220.7***	150.16***	230.86***	–	–	–	–
Corr1	−10.38***	−9.14***	−6.10***	−8.12***	–	–	–	–
Corr2	−0.28	−1.69	−0.78	−1.11	–	–	–	–
Sargan (p-value)	0.000	0.000	0.000	0.000	–	–	–	–
Hansen (p-value)	0.239	0.846	0.592	0.314	–	–	–	–

incorporates the set of control variables, and the column vector $\mathbf{y_{it}}$ refers to the four dependent variables. Therefore, the panel VAR with four equations takes the following form.

$$\begin{pmatrix} S_{it} \\ cash_{it} \\ liquid_{it} \\ tc_{it} \end{pmatrix} = \mathbf{y_{it}} = \alpha + \sum_{j=1}^{p} \Gamma \mathbf{y_{it-j}} + \Xi \mathbf{z_{it-1}} + \theta_i + \varepsilon_{it}. \qquad (2)$$

Our model extends Ozkan et al. (2004) dynamic panel data model by including additional lags as suggested by the Bayesian information criterion and by adding three dependent variables. All eigenvalues lie inside the unit circle, which fulfils the stability condition of the VAR. We test the four dependent variables for unit-roots using the Fisher-type panel test based on an augmented Dickey–Fuller test. This test also considers deterministic trends and cross-sectional differences (firm-specific effects). The test statistic has a p-value of 0.000 and indicates that the four dependent variables are not unit-roots, which ensures that the panel VAR in levels is appropriate.[2]

Table 3 reports the coefficients of the panel VAR based on panel OLS without firm-specific effects and GMM. The results differ substantially, which underline the importance of firm-specific effects and the resulting bias of the least squares estimator. Wald tests reported for the GMM results show that the models have explanatory power. To evaluate the quality of the instruments used for the GMM estimation, Table 3 shows the autocorrelation tests for the first and second lag, the Sargan and the Hansen test. Valid instruments have to be exogenous; hence, the second-order autocorrelation (Corr2) has to be negligible, which is the case, as the tests fail to reject the null hypothesis.[3] The

Sargan and the Hansen tests focus on the overidentification restrictions and assess whether the set of instruments is appropriate. The issue is that the Sargan test assumes homoskedastic errors, whereas the Hansen test is robust. This explains why both tests differ. Accordingly, we use a robust estimation of the variance covariance matrix. The Hansen tests could not reject the null hypothesis that the overidentifying restrictions are valid.[4] In line with Ozkan et al. (2004), Opler et al. (1999) and Harford et al. (2008), the models confirm a high correlation coefficient between current and past levels of cash holding of 0.61 (first lag). Moreover, short-term debt exhibits a similar level of autocorrelation. Accordingly, controlling for lagged variables is essential to obtain reliable estimates. The OLS estimate of the panel VAR shows a high model fit with adjusted R-squared of 64% for short-term finance, 58% for cash holding, 76% for the liquidity measure and 84% for trade credit.

Table 3 shows that some control variables have a statistically significant effect. Firms with high growth in the past year obtain less trade credit, which shows that access to trade credit cannot be relied upon to finance continuing growth. Interest coverage has a significant but very small effect on all time series except the CCC. Firms with high financial leverage exhibit significantly less short-term bank finance and more cash holding, which might be driven by banks denying access to additional short-term lending, and firms holding cash as an alternative funding source. Larger firms have better access to bank finance and hold less cash, in line with prior research (except Harford et al., 2008). There is also a size advantage related to the CCC, which might be due to the stronger negotiating power of larger firms when dealing with suppliers. Profitability increases cash holding, which could be explained by higher cash generation. Trade credit and the CCC increase with profitability. The first relationship can be interpreted as a supply-side effect,

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[2] Detailed results including eigenvalues and unit-root tests are available from the authors on request.

[3] This test is robust in the presence of heteroskedasticity.

[4] Apart from using the first-differenced time series as suggested by Arellano and Bond (1991), which are not always good instruments, we also tried a Helmert's transformation — but the results did not differ (Arellano & Bover, 1995).

Table 4
Granger causality tests and cumulated impulse response functions.

The table shows Granger causality tests for different directions of influence indicated by arrows. Hence, the hypothesis $cash \rightarrow S$ tests whether lagged short-term bank finance ($S_{t-1}, S_{t-2}, S_{t-3}$) influences current levels of cash holding. The test statistic (Chi-square) and the associated p-value are displayed. Columns four to six show the cumulated impulse response functions for one, five and eight years. We used bootstrapping to determine confidence intervals for cumulated impulse response functions. Stars (*, **, ***) indicate significance on the 90%, 95%, and 99% level of confidence respectively. The last column indicates whether the impulse–response relationship can be interpreted as a supply or demand-side effect. If the cumulated impulse response function is not significant, we do not provide an interpretation.

Granger causality tests			Cumulated impulse response function			
Null hypotheses	Chi-square	p-value	1-year	5-years	8-years	Interpretation
$cash \rightarrow S$	0.06	1.00	0.01	−0.01	0.02	–
$liquid \rightarrow S$	11.29	0.01	−0.04	0.10	0.12	–
$tc \rightarrow S$	8.29	0.04	0.17*	0.54*	0.64*	Supply
$S \rightarrow cash$	1.88	0.60	−0.03	−0.05	−0.06	–
$liquid \rightarrow cash$	24.66	0.00	0.08*	0.24*	0.25*	Demand
$tc \rightarrow cash$	27.53	0.00	0.10	0.43	0.48	–
$S \rightarrow liquid$	10.24	0.02	−0.02	−0.10	−0.11	–
$cash \rightarrow liquid$	36.17	0.00	0.09***	0.33***	0.34***	Agency/demand
$tc \rightarrow liquid$	23.36	0.00	0.18**	0.68***	0.74***	Agency/demand
$S \rightarrow tc$	3.82	0.28	0.01	−0.07	−0.09	
$cash \rightarrow tc$	55.43	0.00	0.04**	0.12*	0.14*	Supply
$liquid \rightarrow tc$	57.76	0.00	0.06***	0.20***	0.22***	Demand

as suppliers might be more willing to grant trade credit to a profitable firm. The second effect could indicate that firms with high profitability lack the need to improve working capital management. In contrast to Bates et al. (2009), our measure of cash flow risk has a negative impact on cash holding, albeit the coefficient is very small considering that the variation coefficient has to be between zero and one. Firms with high cost of debt increase cash holding, which might be explained by a substitution effect. These firms also exhibit a slower CCC.

4.3. Granger causality tests and impact multipliers

We test the causal relationships between cash holding, the CCC, trade credit and short-term bank finance. Table 4 shows Granger causality tests based on the GMM estimates, which underline that the CCC and trade credit influence short-term bank finance, whereas cash holding does not have a causal effect. Cash holding in turn is driven by the CCC and trade credit. All three endogenous variables affect liquidity, and cash holding and the CCC affect trade credit. Granger causality tests reveal that the four variables are endogenous and interrelated; thus, using the CCC as an explanatory variable to explain cash holding is misleading

(e.g. Deloof, 2001). To obtain a more precise estimate about the underlying dynamics, we calculate impact multipliers based on the GMM estimates and derive impulse response functions and cumulated impulse response functions. Impulse response functions indicate the response of one variable if another variable changes marginally. We use this methodology to isolate significant impulse–response relationships, which we can interpret as demand or supply-side effects. Using a bootstrapping approach that considers the panel data structure, the original dataset is re-sampled 800 times and the estimated coefficients are obtained. The impact multipliers are calculated based on the 800 point estimates. The percentiles of impact response functions and cumulated impact response functions refer to the respective bootstrapping distribution.

To illustrate the dynamics of the panel VAR, Table 4 summarises cumulated impulse response functions for different periods after the incremental shock. Only a few impulse responses are significant and have a relevant economic impact. The main benefit of using impulse response functions compared to analysing the coefficients in Table 3 is that effects can be isolated. We interpret the impulse–response relationships as either demand or supply-side driven. The supply-side

Table 5
Mismatch of expectations: cash-rich versus average firm.

The annual means of actual cash holding (cash), short-term bank finance (S) and trade credit (tc) are shown for cash-rich firms that belong to the 75-percentile and the average firm. We determine the liquidity shortage (shortage) based on the actual liquidity needs determined by the net working capital and deduct the expected access to external finance. Hence, a positive value indicates that additional short-term funding is required to maintain operations. $\sum E_t$ shows the cumulated forecasting error of cash holding, short-term bank finance and trade credit.

|	Cash-rich firms							Average firm						
Year	cash	$\Sigma E_t(cash)$	S	$\Sigma E_t(S)$	tc	$\Sigma E_t(tc)$	Shortage	cash	$\Sigma E_t(cash)$	S	$\Sigma E_t(S)$	tc	$\Sigma E_t(tc)$	Shortage
1991	0.271	0.001	0.259	0.000	0.128	0.000	0.003	0.103	−0.001	0.250	0.001	0.137	0.000	0.023
1992	0.290	0.003	0.251	0.000	0.119	0.000	0.010	0.113	−0.001	0.248	0.001	0.133	0.000	0.035
1993	0.310	0.004	0.249	0.001	0.122	0.000	0.011	0.126	−0.003	0.238	0.001	0.136	0.001	0.048
1994	0.301	0.005	0.225	0.001	0.122	0.000	0.012	0.128	−0.004	0.233	0.001	0.140	0.002	0.069
1995	0.300	0.007	0.236	0.001	0.124	−0.001	0.018	0.124	−0.006	0.239	0.002	0.142	0.004	0.083
1996	0.325	0.008	0.240	0.002	0.126	−0.001	0.016	0.130	−0.009	0.248	0.003	0.142	0.006	0.083
1997	0.335	0.011	0.252	0.002	0.118	−0.001	0.013	0.140	−0.009	0.253	0.004	0.140	0.007	0.083
1998	0.374	0.013	0.250	0.003	0.111	0.000	0.011	0.146	−0.010	0.255	0.005	0.135	0.007	0.089
1999	0.364	0.014	0.230	0.000	0.106	−0.002	0.011	0.141	−0.011	0.237	0.003	0.128	0.007	0.093
2000	0.407	0.016	0.178	0.000	0.084	−0.003	0.005	0.160	−0.011	0.216	0.002	0.116	0.007	0.083
2001	0.428	0.017	0.178	0.001	0.081	−0.001	0.017	0.163	−0.012	0.219	0.002	0.110	0.006	0.117
2002	0.410	0.028	0.196	0.005	0.089	−0.003	0.011	0.163	−0.011	0.227	0.003	0.110	0.006	0.115
2003	0.408	0.036	0.221	0.004	0.107	−0.003	0.019	0.164	−0.009	0.239	0.004	0.117	0.007	0.119
2004	0.435	0.041	0.202	0.007	0.096	−0.005	0.014	0.182	−0.006	0.230	0.003	0.113	0.007	0.124
2005	0.441	0.045	0.173	0.007	0.084	−0.005	0.024	0.188	−0.004	0.217	0.002	0.107	0.006	0.143
2006	0.436	0.060	0.158	0.006	0.075	−0.010	0.037	0.186	−0.002	0.208	0.001	0.104	0.005	0.164
2007	0.422	0.085	0.167	0.006	0.078	−0.003	0.056	0.179	0.000	0.206	−0.001	0.100	0.003	0.156
2008	0.400	0.086	0.195	0.025	0.087	−0.003	0.090	0.164	0.000	0.213	0.000	0.101	0.000	0.166
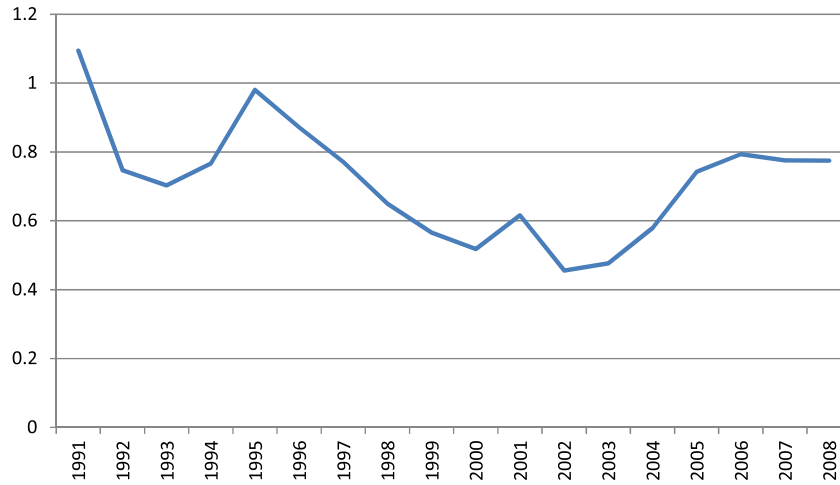
Fig. 2. Difference in predicted cash ratios of surviving and non-surviving firms. The figure plots the difference in forecasted cash ratios of firms that survive during the whole investigation period compared to non-surviving firms. The result is shown in percentage points.

argument focuses on the supply of short-term finance, whereas the demand-side argument highlights the firm's perspective and the demand for liquidity.

Focusing on the supply-side effects of access to short-term bank finance and trade credit, the model makes the following predictions: (1) An increase in trade credit by 1% increases the level of short-term bank finance by 0.64% (cumulative effect after eight years); hence, the finding supports the complementary nature of trade credit and short-term bank finance (Bias & Gollier, 1997; Burkart & Ellingsen, 2004). From the perspective of banks, an increase in trade credit signals private information of suppliers, which reduces the information asymmetry between the firm and the bank, which in turn improves access to bank finance. (2) Cash holding has a positive impact on trade credit, which shows that suppliers could consider cash as a positive signal concerning the firm's ability to pay back the trade credit offered.

Isolating the demand-side effects that explain the need for cash holding and other sources of short-term finance, the cumulated impulse response functions illustrate the following relationships. (1) Firms facing a higher liquidity need due to a longer CCC increase cash holding. (2) On a similar note, a slower CCC triggers more trade credit, which we interpret as a demand-side effect, as firms with high liquidity needs and financial distress tend to rely more on trade credit, which is relatively expensive. In addition, we observe two demand-side effects, which could be interpreted in the context of agency theory. The cash holding literature focuses on agency costs related to cash holding in the context of long-term decisions such as mergers and acquisitions (Harford, 1999; Graham & Harvey, 2001). Even in the short-term, agency costs could be relevant in the context of working capital management, for managers that have additional cash or other sources of funding might not be willing to make the effort to improve the CCC. (3) The impulse response functions illustrate that more cash holding increases the CCC, (4) and an increase in trade credit has an even stronger effect. In contrast, additional short-term bank finance does not cause an increase in the CCC, which can be explained by the monitoring role of banks that define and control liquidity measures.

4.4. Out-of sample forecasts and cash-rich firms

Based on the panel VAR, we forecast the level of cash holding and compare fitted values to actual cash holding over time to detect any inconsistencies due to parameter instability or other time related unobserved variables. The parameters seem to be stable, and the model fit does not depend on the time period selected. To check whether the predictions are reliable, we determine one-step-ahead forecasts. Table 5 shows cumulated forecasting errors, which indicate whether the model over- or understates the respective dependent variable. The cumulated forecasting error in 2008, which refers to the whole period from 1991 to 2008, reveals that the model forecasts cash holding ($\sum E_t(cash)$), short-term bank finance ($\sum E_t(S)$) and trade credit ($\sum E_t(tc)$) with great precision.

However, isolating firms with high cash holding defined as above the 75-percentile in 1988 uncovers that the model understates the stockpiling of cash by cash-rich firms. These firms increased cash ratios from 27.1% to 40.0%. Accordingly, the observed increase was 12.9 percentage points; however, the model made a cumulative forecasting error of +8.6 percentage points (shown in year 2008 in Table 5). This means that the model predicted that cash holding of cash-rich firms would increase by 4.3 percentage points (i.e. 12.9–8.6), which understates the actual accumulation of cash. The observed increase in average cash holding as shown in Fig. 1 is mainly due to the rapid accumulation of cash by firms belonging to the 75-percentile in 1988.

Comparing cash-rich firms to the average firm reveals that there is a substantial mismatch between expected and actual access to short-term bank finance. Table 5 reveals this mismatch in column $\sum E_t(S)$ and shows in row 2008 that expected access to bank-finance exceeds the actual access by 2.5 percentage points in the case of cash-rich firms. Accordingly, the increase in cash holding compensates for the lack of access to short-term bank finance. In contrast, trade credit was in line with expectations indicated by $\sum E_t(tc)$ in row 2008 reaching only −0.3 percentage points. Cash-rich firms could reduce the risk of a liquidity shortage, defined as actual liquidity in excess of expected access to external finance, through cash holding. The likelihood of a shortfall has increased sharply since the start of the recent financial crisis with cash-rich firms exhibiting a substantially reduced risk compared to the sample average. From a modelling perspective, the panel VAR does not impose any theoretical restrictions, which is both the benefit and weakness of VAR models. On average the panel VAR predicts the increase in cash holding correctly. But some firms face an unexpected shortage of external funding and need to mitigate the risk of liquidity shortages by holding more cash.[5]

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[5] We can show using a panel probit model that the risk of a liquidity shortage can be reduced through cash holding (p-value 0.017). In addition, firm size mitigates the risk (p-value 0.000) as does profitability (p-value 0.040) — but a high financial leverage increases the likelihood of a shortage (p-value 0.008).

5. Robustness checks

5.1. Survivorship bias

Any panel data study might suffer from a survivorship bias, for some companies are delisted during the investigation period. Mergers and acquisitions are the most likely cause of a delisting. It is possible that the changing number of cross-sectional units has an impact on the empirical outcome; therefore, we distinguish between firms that are listed during the whole investigation period and those that are listed later or delisted. The panel VAR (Eq. (2)) is re-estimated for the two subgroups of firms, and the results do not differ qualitatively. An alternative method is to include the number of years listed as an additional variable of the panel VAR and analyse whether firms with a longer listing history exhibit different levels of the four endogenous variables. The number of years listed does not influence cash holding nor liquidity needs, whereas trade credit and short-term bank finance are significantly affected, albeit the magnitude of influence is very low with coefficients of 0.0002 and 0.0008 respectively. The alleged survivorship bias does not alter our findings, and the listing period has only a minor effect on trade credit and short-term bank finance. This suggests that the period of listings has a negligible impact on cash holding in contrast to Bates et al. (2009). To illustrate the potential survivorship bias, Fig. 2 plots predicted cash ratios for surviving and non-surviving firms. As expected, non-surviving firms exhibit on average lower cash-ratios compared to surviving firms; however, the difference amounts to 0.7 percentage points from 1991 to 2008, which is negligible. Moreover, the difference seems to be stable over time; thus, an alleged survivorship bias cannot explain the increase in cash holding.

5.2. Cash holding to cover expected operating losses

Motivated by Opler et al. (1999), who contend that operating losses reduce cash holding, one could argue that firms hold cash to cover future operating losses. Applying a panel probit model that explains whether a firm experiences an operating loss or not, we predict the probability of operating losses. The expected probability is then included into the panel VAR as a predetermined variable. Note that the expected probability in t is based on information available in t − 1; hence, the variable is weakly exogenous. There is a sharp increase in the expected probability of operating losses from 5.6% in 1990 to 18.2% in 2008; however, the partial impact on cash holding is limited with a coefficient of 0.046 (p-value of 0.017). Accordingly, even if the predicted probability reaches one, the expected level of cash holding increases only by 0.046 percentage points, which does not explain the substantial increase in cash holding since 2001.[6]

6. Conclusion

This paper focuses on cash holding and its closest substitutes, short-term bank finance and trade credit. We determine the firm's need for liquidity based on the CCC. A panel VAR approach extends prior empirical models and reveals the dynamic relationship between cash and other short-term sources of funding. Granger causality tests show that all four variables are endogenous and hence single-equation models used in the literature might suffer from an endogeneity bias (e.g. Deloof, 2001). Moreover, impulse response functions can isolate the dynamic impact of an incremental change of one endogenous variable on another. We interpret different impulse–response relations as demand or supply-side driven. Trade credit increases short-term bank finance, which we regard as a supply-side effect based on the signalling theory of trade credit (Bias & Gollier, 1997; Burkart & Ellingsen, 2004).

Additional cash holding triggers an increase in trade credit, which can be viewed as a supply-side effect, as suppliers might be more willing to provide trade credit to firms with higher cash holding. There are two demand-side effects. A short-term liquidity shock causes more cash holding and trade credit; thus, firms do not prefer bank finance in case of unexpected liquidity needs. We also argue that there are two demand-side effects that could be explained by agency theory. The availability of additional cash or trade credit causes a slowdown of the CCC. Therefore, one could argue that firms that have sufficient funding do not improve their CCC in spite of the fact that a faster CCC would create more shareholder value. Improving working capital management takes effort and might alienate customers. Additional short-term bank finance does not have any impact on the CCC, which we explain by the monitoring role of banks and predefined levels of liquidity measures.

The panel VAR can forecast the four endogenous variables accurately; however, the in-sample heterogeneity shows that firms belonging to the 75-percentile in terms of cash holding experience an unexpected decline in short-term bank finance. Firms faced with an unexpected shortage of external funding react by increasing cash holding. The panel VAR and the unexpected decline in short-term bank finance can explain to a large extent the recent increase in cash holding. The robustness checks address a potential survivorship bias and evaluate the impact of operating losses on cash holding.

Our study shows that short-term bank finance improves the liquidity of firms without causing a deterioration of working capital discipline. We observe a pronounced decline in short-term bank finance in the UK, which contributes to the accumulation of cash. From a policy perspective, improving access to short-term bank finance is beneficial, as the substitutes, cash holding and trade credit, cause agency costs due to an increase in the CCC.

References

Ang, J., & Smedema, A. (2011). Financial flexibility: Do firms prepare for recession? *Journal of Corporate Finance, 17*, 774–787.
Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The Review of Economic Studies, 58*, 277–297.
Arellano, M., & Bover, O. (1995). Another look at the instrumental variable estimation of error-component models. *Journal of Econometrics, 10*, 29–51.
Bates, T. W., Kahle, K. M., & Stulz, R. M. (2009). Why do U.S. firms hold so much more cash than they used to? *Journal of Finance, 64*, 1985–2021.
Beltz, J., & Frank, M. (1996). Risk and corporate holdings of highly liquid assets. *working paper*.
Bias, B., & Gollier, C. (1997). Trade credit and credit rationing. *The Review of Financial Studies, 10*(4), 903–937.
Burkart, M., & Ellingsen, T. (2004). In-kind finance: A theory of trade credit. *The American Economic Review, 94*(3), 569–590.
D'Mello, R., Krishnaswami, S., & Larkin, P. J. (2008). Determinants of corporate cash holdings: Evidence from spin-offs. *Journal of Banking & Finance, 32*(7), 1209–1220.
Deloof, M. (2001). Intragroup relations and the determinants of corporate liquid reserves: Belgian evidence. *European Financial Management, 7*, 375–392.
Ferreira, M. A., & Vilela, A. S. (2004). Why do firms hold cash? Evidence from EMU countries. *European Financial Management, 10*(2), 295–319.
Gama, A. P., Mateus, C., & Teixeira, A. (2008). Does trade credit facilitate access to bank finance? Empirical evidence from Portuguese and Spanish small medium size enterprises. *working paper*.
Gitman, L. J. (1974). Corporate liquidity requirements: A simplified approach. *The Financial Review, 9*, 79–88.
Graham, J. R., & Harvey, C. R. (2001). The theory and practice of corporate finance: Evidence from the field. *Journal of Financial Economics, 61*, 187–243.
Harford, J. (1999). Corporate cash reserves and acquisitions. *Journal of Finance, 54*, 1969–1997.
Harford, J., Mansi, S. A., & Maxwell, W. F. (2008). Corporate governance and firm cash holding. *Journal of Financial Economics, 87*, 535–555.
Jain, N. (2001). Monitoring costs and trade credit. *Quarterly Review of Economics and Finance, 41*(1), 89–110.
Jensen, M. (1986). Agency costs of free cash flow, corporate finance and takeovers. *American Economic Review, 76*, 323–329.
John, T. A. (1993). Accounting measures of corporate liquidity, leverage, and costs of financial distress. *Financial Management, 22*, 91–100.
Keynes, J. M. (1936). The general theory of employment. *interest and money*. London: Harcourt Brace.
Meltzer, A. H. (1960). Mercantile credit, monetary policy, and size of firms. *Review of Economics and Statistics, 42*(4), 429–443.

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[6] Detailed results are available from the authors on request.

Miller, M. H., & Orr, D. (1966). A model of the demand for money by firms. *Quarterly Journal of Economics, 80*, 413–435.

Myers, S. (1977). Determinants of corporate borrowing. *Journal of Financial Economics, 5*, 147–175.

Myers, S. C., & Majluf, N. S. (1984). Corporate financing and investment decisions when firms have information that investors do not have. *Journal of Financial Economics, 13*, 187–221.

Nadiri, M. I. (1969). The determinants of trade credit in the U.S. total manufacturing sector. *Econometrica, 37*(3), 408–423.

Nilsen, J. H. (2002). Trade credit and bank lending channel. *Journal of Money Credit and Banking, 34*(1), 226–253.

Opler, T., Pinkowitz, L., Stulz, R., & Williamson, R. (1999). The determinants and implications of cash holding. *Journal of Financial Economics, 52*, 3–46.

Ozkan, A., Ozkan, N., & N. (2004). Corporate cash holdings: An empirical investigation of UK companies. *Journal of Banking and Finance, 28*, 2103–2134.

Petersen, M. A., & Rajan, R. G. (1997). Trade credit: Theories and evidence. *The Review of Financial Studies, 10*(3), 661–691.

Tobin, J. (1956). The interest elasticity of transactions demand for cash. *Review of Economics and Statistics, 38*, 241–247.

Wang, Y. -J. (2002). Liquidity management, operating performance, and corporate value: Evidence from Japan and Taiwan. *Journal of Multinational Financial Management, 12*, 159–169.