

All You Need is Cash: Corporate Cash Holdings and Investment after the Global Financial Crisis*

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Abstract

This paper studies how cash holdings at the onset of the global financial crisis affected the investment behavior of SMEs after the shock. Using balance sheet data for UK SMEs, we find that cash-rich SMEs maintained their capital stock during the global financial crisis, while cash-poor rivals reduced theirs. This gave cash-rich SMEs an advantage when the economy rebounded, resulting in a persistent investment gap that grew during the recovery period. Competition dynamics, borrowing constraints and precautionary savings contributed to this amplification effect. The amplification effect was more pronounced for younger and smaller firms and in industries where credit conditions tightened more. We do not observe a persistent effect of cash in non-crisis periods or for publicly listed firms. Our findings show that when financial constraints tighten after crises, cash holdings are a key determinant of investment by SMEs in the long term.

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1 Introduction

In many countries, small and medium-sized enterprises (SMEs) account for the lion's share of employment and output and are important drivers of innovation and growth (Haltiwanger, Jarmin and Miranda, 2013; Acemoglu et al., 2018), but , economic downturns are particularly challenging for SMEs. Their activities tend to be less diversified and downsizing is often difficult, making them more vulnerable to a sudden fall in demand. They also typically require more screening and monitoring by lenders, so banks tend to cut credit to SMEs more aggressively during crises (Chodorow-Reich, 2014; Chodorow-Reich et al., 2022; Greenwald, Krainer and Pascal, 2020). And when they do so, SMEs are less able to switch to other types of external funding and have to rely on internal sources of finance instead (Iyer et al., 2014; Cingano, Manaresi and Sette, 2016). This suggests that cash buffers are a key determinant of SME performance after financial crises.

In this paper, we examine the role of cash holdings for SMEs' performance during the global financial crisis and its aftermath. We find that firms' cash holdings at the onset of the crisis had a positive effect on investment during the crisis which increased during the recovery period. The persistence of the cash effect is consistent with a self-reinforcing feedback loop whereby low initial cash holdings forced SMEs to reduce investment during the crisis, which in turn led to market share losses, lower profits and tighter borrowing constraints during the recovery period. These factors contributed to further declines in investment activity and resulted in a widening of the investment gap between initially cash-poor and initially cash-rich SMEs during the recovery period. We do not observe this effect outside of crises episodes or for publicly listed firms, suggesting that access to external finance which would allow firms to break out of the feedback loop is crucial in driving these dynamics.

There are several reasons why having cash buffers at the onset of a crisis makes it easier for firms to continue to operate and invest. First, cash provides a firm with an internal source of funds when credit conditions tighten, external finance becomes more costly and cash flow declines. Second, when asset prices decline, cash preserves its value which protects the firm's net worth. This reduces lenders' exposure to losses and can lower borrowing costs (Bernanke and Gertler, 1989). Third, a cash-rich firm does not have to increase its cash holdings for precautionary motives in the wake of a negative shock and can use these funds for investment instead (Almeida, Campello and Weisbach, 2004; Berg, 2018). For these reasons, SMEs with cash are more likely to have sufficient funds to replace fixed assets that have depreciated and to seize profitable investment opportunities. Their cash-starved rivals by contrast may lack the funds to finance investment and may even struggle to survive.¹

¹While not focusing explicitly on the role of cash, Campello, Graham and Harvey (2010) show that firms that identify themselves as financially constrained during the crisis planned deeper cuts in employment and capital spending, were forgoing otherwise attractive investment opportunities and sold assets in order to fund operations.

Differences in firm behavior during the crisis can impact investment when the recovery sets in. If cash-rich firms are able to maintain their productive capacity, while cash-poor firms have to reduce theirs, competition dynamics change. When the recovery sets in and demand rebounds, cash-rich firms have more capacity to meet this demand. They can reinvest their earnings to further expand their productive capacity. By contrast, cash-poor rivals that lost productive capacity, struggle to meet demand. This results in reduced revenue, limited funds for reinvestment and a further weakening of their positions. These effects are magnified if financial constraints remain tighter for cash-poor firms or if these firms choose balance sheet repair over investment. Due to these feedback effects, the investment gap between cash-rich and cash-poor SMEs that opens up during a crisis may widen during the recovery period.

Simple correlations between initial cash and subsequent investment suggest that having cash at the right moment in time has long-term implications: When we rank SMEs according to the size of their cash holdings relative to their industry rivals just before the start of the global financial crisis, a striking relationship with investment over the period 2007-2014 emerges (Figure 1, top panel). While SMEs with a lot of cash maintained or even increased their fixed assets between 2007 and 2009, cash-poor firms decreased theirs. Importantly, this divergence in investment behavior became more pronounced during the recovery period. The correlation between SMEs' cash holdings and their subsequent investment is different in normal times. When we rank firms according to the size of their cash holdings relative to their industry rivals in the year 2000, a weak relationship with investment over the subsequent period emerges: Both cash-rich and cash-poor firms increased their fixed assets between 2001 and 2007 (Figure 1, bottom panel).²

To examine formally how pre-crisis cash holdings affected investment during the global financial crisis and the recovery period we use a local projections framework (Jordà, 2005). We assess how investment over different horizons between 2007 and 2014 responded to the financial crisis conditional on pre-crisis cash holdings. We measure firms' cash holdings just before the start of the crisis and exploit the fact that the sharp credit contraction after the collapse of Lehman Brothers was unexpected. It is therefore unlikely that firms were hoarding cash prior to the crisis in anticipation of a credit supply shock that would affect their future ability to invest. We control for a range of firm characteristics that are correlated with cash holdings and could potentially affect firms' ability or willingness to invest. In addition, we include 4-digit industry and regional fixed effects to absorb for each investment horizon the impact of industry and regional conditions.

To further mitigate concerns that cash is endogeneously related to post-crisis investment, we introduce a novel identification strategy which exploits the empirical regularity that for a significant number of UK SMEs, cash holdings exhibit a very low correlation year-on-year (Figure 2).³ Cash holdings of these SMEs appear to be primarily driven by variation in sales, produc-

²The variation in cash holdings within industry is very similar in the two years. As such the differential pattern cannot be explained by sharp differences in initial cash holdings in the two periods.

³On average the 1-lag autocorrelation of a firm's cash holdings is only 0.15.

tion patterns and resulting cash flows. For such firms, it is less likely that cash holdings at the onset of the crisis were correlated with unobserved characteristics such as for example prudent management or long-term investment opportunities. Furthermore, a shock like the global financial crisis weakens the correlation between anticipated investment opportunities and actual investment opportunities. Even if SMEs with volatile cash were holding cash prior to the crisis for investment purposes, it is unlikely that such opportunities remained viable or desirable after the shock.

We find that SMEs with high initial levels of cash invested more during the crisis. The differential effect was the result of two opposing forces: Firms with large cash buffers (90th percentile of the distribution) maintained their stock of fixed assets between 2007 and 2009 while firms with low cash buffers (the 10th percentile) reduced theirs, resulting in an investment gap of close to 5 percentage points. In line with the feedback loops described above, we find that the positive effect of pre-crisis cash holdings persisted during the recovery period: By 2014, cash-rich SMEs had increased their stock of fixed assets by 4.4 percent relative to 2007, while cash-poor SMEs had decreased their fixed assets by 7.4 percent. The size of the investment gap between cash-rich and cash-poor firms thus more than doubled during the recovery period to reach 11.8 percentage points. We find similar patterns for our sample of SMEs with volatile cash holdings.

The persistence of the cash effect is unique to SMEs and unique to post-crisis periods. During the pre-crisis period, we find that the effect of initial cash holdings by SMEs was only significant in the short term and much smaller than during the crisis period. We do not find an amplification of the cash-effect in the long term. When we examine the impact of cash holdings on investment by UK publicly listed firms during the crisis and the recovery periods, we find that initial cash holdings did not have a significant effect on investment beyond the the crisis period. This is consistent with evidence for large firms in the US (Duchin, Ozbas and Sensoy, 2010). We attribute the lack of persistence of the cash-effect for publicly listed firms to their ability to regain access to external finance soon after the initial shock, allowing them to circumvent self-reinforcing feedback loops.

Differences in the size of the cash effect across SMEs and industries with different characteristics also suggests that financial constraints are a key driver of our results. We find, for both the full sample of SMEs and the sample of volatile cash firms, that the impact of cash was larger for young and small SMEs, in line with the well-documented fact that young and small firms tend to be more affected by credit supply shocks (Chodorow-Reich, 2014, Ongena, Peydro and Van Horen, 2015, Cingano, Manaresi and Sette, 2016). Similarly, the cash-effect was larger in industries where credit conditions were likely tighter during and after the crisis.

Our evidence supports three potential mechanisms that can explain the persistence and widening of the investment gap during the recovery period. The first mechanism relates to a shift in competition dynamics. The ability of cash-rich SMEs to maintain their productive capacity,

while cash-poor rivals were forced to shrink theirs, gave cash-rich firms a competitive edge during the recovery period. This advantage allowed them to generate more income, reinvest these earnings and capture more market share over time. Cash-rich firms might have further bolstered their competitive position by acquiring discounted assets, lowering prices or investing strategically (Campello, 2006; Gilchrist et al., 2017). In line with this mechanism, we document a positive effect of pre-crisis cash holdings on both market share growth and profits during the crisis, which was amplified during the recovery phase.

The second mechanism relates to borrowing constraints. It suggests that the crisis-induced tightening of borrowing constraints affected cash-rich SMEs less than their cash-poor counterparts. Larger cash balances protect the net worth of cash-rich firms, making them less risky for lenders. Even when credit conditions improved during the recovery period, banks likely preferred lending to cash-rich firms with more fixed assets to pledge as collateral and with better earning histories (Ivashina, Laeven and Moreno, 2022; Lian and Ma, 2021). Consistent with this mechanism, we find that cash-poor SMEs experienced a sharper decline in their debt levels during the crisis and the recovery period. While this effect could partly be driven by credit demand, we also document a persistent worsening of credit scores of cash-poor firms relative to those of cash-rich firms.

The third mechanism relates to precautionary savings that firms accumulate as an insurance against risks. Firms tend to increase their cash reserves following downturns due to heightened uncertainty, limited access to external finance, and the need for operational flexibility (Almeida, Campello and Weisbach, 2004; Berg, 2018; Xiao, 2019). Furthermore, after negative shocks firm managers tend to shift from over-optimism to over-pessimism and reevaluate risks accordingly (Bordalo, Gennaioli and Shleifer, 2018). This can prompt them to raise their optimal level of cash reserves for a prolonged period, especially when economic conditions remain uncertain (as was the case in Europe due to the sovereign debt crisis). For SMEs entering the crisis with very low cash reserves, prioritizing balance sheet repair over incremental investments might be crucial to prevent default. In line with this, we document that cash-poor SMEs increased their cash holdings relative to their cash-rich rivals during the crisis and the recovery period. This differential effect persisted during the recovery period, consistent with the fact that firm managers targeted higher liquidity ratios post-crisis and that it can take a long time to build up cash reserves when cash flow and profits are low.

Lastly, we investigate the impact of cash holdings on the survival of SMEs. We find that UK SMEs with high levels of cash were less likely to exit during the crisis and recovery period. By 2009, 3.4 percent of the firms in our sample had exited. For cash-poor firms this number was significantly higher at 4.7 percent than for cash-rich firms of which only 2 percent had exited. The cash-effect amplified until 2011. By then, 13 percent of the cash-poor SMEs had exited while only 8 percent of cash-rich ones did. From 2012 onward the cash-effect declines slightly but the coefficients are not significantly different from the coefficient for survival up until 2011.

Therefore, while initially cash-rich firms were more likely to have survived by 2014, this effect was driven by the positive impact of cash on survival prior to 2012. This evidence complements our main findings on the investment of SMEs that survived both the crisis and recovery period and again shows that the impact of balance sheet strength going into the crisis affects SMEs not only during the crisis, but in the recovery period as well.

The main contribution of our paper is to document a large and persistent effect of initial cash-holdings on investment that is unique to SMEs and to crisis periods. This novel finding adds to the large literature studying the real effects of the global financial crisis, which has primarily focused on short-term effects, the role of leverage and publicly listed firms (e.g. Campello, Graham and Harvey, 2010; Almeida et al., 2012; Giroud and Mueller, 2017; Wix, 2017; Kalemli-Ozcan, Laeven and Moreno, 2022; Duval, Hong and Timmer, 2020). The role of cash has received less attention, but there is evidence for publicly listed US firms that limited cash holdings reduced investment (Duchin, Ozbas and Sensoy, 2010) and employment (Schoefer, 2015) during the global financial crisis. Our study complements these findings by focusing specifically on SMEs and by comparing the short-term and the long-term effects of the crisis. We demonstrate that balance sheet conditions at the onset of a crisis have different long-term implications for SMEs and publicly listed firms. To the best of our knowledge, our paper is the first to highlight that tight financial constraints faced by SMEs after crises can give rise to self-reinforcing feedback loops which make initial cash holdings a key determinant of SME performance in the long term.

Our evidence on competition dynamics as a potential mechanism that drove the widening of the investment gap after the crisis is also related to the work by (Fresard, 2010). Fresard (2010) documents a positive effect of cash holdings on future market shares of publicly listed US firms after a shock to industry competition. We focus instead on SMEs' responses to a credit supply shock and relate the widening investment gap during the recovery period to a change in competition dynamics. We also complement the work of Fresard, 2010 by demonstrating that after a credit supply shock large cash holdings provide a long-term advantage to SMEs but not to publicly listed firms.

Our paper also adds to the literature on corporate liquidity management which, partly due to data limitations, has primarily focused on large, publicly listed (US) firms. Existing studies have shown that financially constrained firms hold more cash for precautionary reasons (e.g. Opler et al., 1999; Faulkender and Wang, 2006; Acharya, Almeida and Campello, 2007; Cunha and Pollet, 2020). Following a negative macroeconomic or funding shock, firms tend to increase cash holdings (Almeida, Campello and Weisbach, 2004, Song and Lee, 2012) and to reduce investment and employment (Berg, 2018; Bancchetta, Benhima and Poilly, 2019; Melcangi, 2023).⁴ In addition, cash reserves enable financially constrained firms to invest more, partic-

⁴Related, Begenau and Palazzo (2021) show that firms dynamically adjust the proportion of cash flow they save to avoid having to finance their growth in the future at a higher cost.

ularly when hedging needs are high (Denis and Sibilkov, 2010), and they serve as a safeguard against contractionary monetary policy or credit supply shocks (Jeenas, 2018; Ottonello and Winberry, 2020; Beck, Da-Rocha-Lopes and Silva, 2021).⁵ Our paper provides novel insights into the importance of cash holdings for SMEs' long-term investment and their probability of survival following a large financial shock.

Finally, we contribute to the literature by introducing a novel method to identify the real effects of cash holdings for SMEs. Previous studies have addressed endogeneity concerns by extracting the unexplained portion of corporate cash holdings (see Opler et al., 1999) but controlling for all major determinants of cash holdings is not feasible for SMEs with basic reporting requirements. Other papers have exploited quasi-natural experiments (e.g. Fresard, 2010) but policy reforms or economic changes may not coincide with a crisis or some other period of interest. In this paper, we identify the cash effect by focusing on firms with unsystematic variation in cash holdings over time. Although some correlation between cash holdings and anticipated investment opportunities may still remain, this identification strategy offers the advantage of minimal data requirements, easily interpretable coefficients on cash holdings and flexibility in studying different time periods or institutional environments.

The remainder of the paper is structured as follows. The next section introduces the data and Section 3 our empirical strategy. Section 4 reports the results on the long-run effects of cash on investment. Section 5 presents evidence on three potential underlying mechanisms and Section 6 studies how cash affects firm long-term survival. Section 7 concludes.

2 Data and summary statistics

In this section, we describe the data sources and key variables that we use in our analysis

2.1 Firm balance sheet data

Our primary data source is the FAME database provided by Bureau van Dijk (BvD). The FAME database is a subset of the more commonly used Amadeus (European firms) and Orbis (global firms) datasets that BvD compiles. It includes balance sheet information, cash flow statements and profit and loss accounts of UK companies. The data are collated from the publicly available filings of firms with Companies House, the official UK firm registrar, and therefore capture a large portion of the UK's corporate universe.⁶ Datasets such as Compustat

⁵The findings in these papers are consistent with the idea that higher cash holdings are a value-increasing response to costly external finance. An alternative view presented in the literature is that financially constrained firms hold high cash reserves due to value-reducing agency problems and empire-building behavior of managers (Jensen and Meckling, 1976; Harford, 1999; Pinkowitz, Stulz and Williamson, 2006; Dittmar and Mahrt-Smith, 2007; Harford, Mansi and Maxwell, 2008).

⁶Companies House collects and publishes data on registered companies subject to the Companies Act 2006, including limited liability firms and partnerships but excluding sole traders.

and Worldscope that are commonly used in the literature on the real effects of financial crises and the literature on corporate cash holdings only contain information on large and publicly listed companies. By contrast, the vast majority of companies in FAME are small and medium sized firms (SMEs) and privately owned. The FAME dataset therefore allows us to study the type of firms that were more likely to be affected by a tightening of financial conditions during the crisis.

In order to investigate whether SMEs' cash-investment sensitivities change during a crisis and its aftermath we need to make a comparison with the pre-crisis period. This requires a relatively long time series. FAME is a live database and historical information on inactive or dissolved companies is only retained up to five years after firm exit. Relying on a recent FAME download would therefore introduce survival bias in the earlier years of our analysis. To obtain representative firm accounts for the pre-crisis period, we download archived vintages of firm accounting data and overlay the balance sheet information from these different vintages using unique firm identifiers and account filing dates.⁷ Whenever balance sheet information for a firm and year is available from multiple vintages of data or sets of accounts, we prioritize the most recent vintage.⁸ This exercise reduces survival bias and substantially improves data coverage.⁹ Our final dataset covers the period 1999-2014

In the UK, reporting requirements vary by firm size. Basic information is available for all firms but many variables (such as EBITDA, turnover, employment, etc.) are only reported by larger firms.¹⁰ Firms are classified using 4-digit codes of the 2007 UK Standard Industry Classification. We follow the literature and exclude firms that operate in industries that provide financial services, are in real estate or are dominated by the public sector.¹¹ We also exclude industries with less than 30 firms. We only use the unconsolidated accounts of firms to avoid double-counting and to ensure that we focus as much as possible on the domestic component of the activity of firms that operate internationally. Our dataset covers firms that are single entities and firms that are part of a group (10 percent of the firms in our sample). Firms that

⁷As discussed in great detail by Kalemli-Ozcan et al. (2015) and implemented for the UK by Bahaj, Foulis and Pinter (2020), the use of historical information and careful treatment of the data is crucial to construct an accurate firm-level panel using data provided by BvD.

⁸We use the following vintages: March 2007, April 2012 and May 2017.

⁹Another complicating factor is that firms in the UK are not required to submit their accounts during a specific month of the year. Firms' annual accounts therefore cover different 12-month periods depending on the reporting month. Most firms, however, submit their accounts at the end of the calendar year or at the end of the fiscal year. To determine which calendar year the firm's accounts correspond to, we assign accounts reported in the first half of a year to the previous calendar year and reports submitted in the second half of a year to the current calendar year, i.e. accounts submitted until June 2007 are assigned to the year 2006. The vast majority of accounts cover a 12-month period. Occasionally, we also observe irregular filings or multiple filings in a single year. In the case of irregular filings, we assign as the accounting year the year into which most of the accounting period fell. In case of multiple filings, we calculate weighted averages to match the usual 12-month reporting period.

¹⁰See Bahaj, Foulis and Pinter (2020) for a detailed description of firm reporting requirements in the UK.

¹¹Specifically, we exclude firms operating in finance and insurance, real estate, public administration, education, human health and social work, activities of households as employers and activities of extraterritorial organizations and bodies.

are part of a group can potentially also access capital from their parent which could reduce the importance of cash holdings as a determinant of a firm's investment decisions. We control for this in our analysis.

Since many firms do not report employment, we classify SMEs based on their total assets. To identify SMEs, we use the threshold set out in the UK Companies Act and only include firms with total assets of less than £18 million. In our main analysis, we focus on the set of firms that survived both the crisis and the recovery period. This ensures that any change in the cash-investment sensitivity over time cannot be attributed to firms that are exiting or entering the market. The sample for our baseline investment analysis consists of 204,412 SMEs. Our pre-crisis sample consists of 135,617 SMEs that were active over the full pre-crisis period. In the final section of the paper, we examine whether cash holdings going into the crisis affected a firm's probability of survival. For this, we include all SMEs for which we have complete data for each year they have been active. Our sample for the survival analysis includes 259,416 firms.

To assess whether cash-investment sensitivities are different for UK publicly listed firms, we construct a similar dataset containing only publicly listed firms. We focus exclusively on firms that were listed between 2005 and 2014 in order to ensure that their balance sheets were not affected by firms' listing or de-listing. We exclude the same industries as we do for our sample of SMEs and exclude industries with less than 20 firms. We obtain a sample of 259 publicly listed firms.

2.2 Regression variables

Our dependent variable is the growth rate of fixed assets, which as we explain in the next section, is measured over different horizons. Investment in fixed assets can be measured on a gross or net basis i.e. with or without depreciation. If investment expenditures equal the depreciation of capital equipment, then gross investment is positive, but net investment is zero. We focus on net investment since net investment matters most for the productive capacity of the firm.

Our key variable of interest is the level of cash a firm holds at the onset of the global financial crisis. It is well-established in the literature that firm's cash holdings vary significantly across sectors as the importance of cash holdings to mitigate financial constraints differs across industries. Cash holdings are for example more valuable in industries with volatile cash flows (Kim, Mauer and Sherman, 1998; Opler et al., 1999; Han and Qiu, 2007) and in industries where the correlation between cash flows and investment opportunities is low (Acharya, Almeida and Campello, 2007). However, firms' cash holdings also vary a lot within narrowly defined industrial sectors (Figure 3). This means that at any given point in time some SMEs in an industry will have large amounts of cash while others only very little. We are primarily interested in

this variation within industries since the competitive advantage that an SME potentially gains by holding cash will depend on the cash holdings of its competitors.

To construct a measure of relative cash holdings, we follow MacKay and Phillips (2005) and Fresard (2010) and standardize the ratio of cash to total assets within each 4-digit industry. Specifically, we compute *Relative cash* by subtracting from the firm’s cash-to-asset ratio the industry mean of the ratio and divide the difference by the industry standard deviation, all measured in 2006. This measure takes into account that the cash holdings of a firm with a cash-to-asset ratio that exceeds the industry mean by 5 percentage points provide more value in an industry with a standard deviation of 3 percent than they do in an industry with a standard deviation of 10 percent. We show that our results are robust to using alternative measures of cash holdings, including the simple cash-to-asset ratio and a measure of excess cash (Section 4.5).

We create a number of firm-specific variables to include as control variables in our analysis. Small and young SMEs tend to rely more on internal funds to finance their investment. It is therefore important to control for firm size and age to assess the independent effect of relative cash holdings. We define the variable *Size* as the log of total assets in 2006. We create two dummy variables to differentiate between firms at different stages of their life cycle: *Mature* which is one if the firm’s age in 2006 was between 10 and 19 years and *Old* which is one if the firm was 20 years old or older.

A number of studies show that the debt had a negative effect on investment during the crisis period (see, among others, Duval, Hong and Timmer, 2020, Kalemli-Ozcan, Laeven and Moreno, 2022). Leverage might also be correlated with cash holdings. We control for *Leverage* measured as the firm’s total liabilities over total assets in 2006. To control for the firm’s pre-crisis performance, we include *ROA* as measured by the firm’s profits over total assets in 2006. Some of the SMEs in our sample are part of a group structure and have access to funds through their corporate group. To control for this, we include a dummy variable *Group* which is one if the firm has a parent, which we capture by the firm reporting an ultimate owner in FAME.¹²

Investment tends to be lumpy and is often partly financed with internal funds. Firms with low cash holdings in 2006 might have invested in the preceding years and might have lower investment needs in the years to come. We therefore create the variable *Pre-Investment* which equals the log difference of fixed assets between 2005 and 2006 and between 2006 and 2007. For the subset of firms that report turnover, we also construct a measure of their pre-crisis performance. *Pre-Turnover* is defined as the log difference of turnover over the same years as *Pre-Investment*. To limit the effect of outliers, we drop observations below the first and above the 99th percentile for the continuous firm variables. Descriptive statistics are shown in Table 1.

¹²We thank Bahaj, Foulis and Pinter (2020) for sharing this information with us.

3 Empirical methodology

Our paper aims to test whether the pre-crisis cash position of a firm relative to its industry rivals is a strong predictor of long-term investment after a financial crisis. In this section, we explain the empirical methodology for our investment regressions and the way we deal with the concern that a firm’s cash position might be endogenously related to its investment decisions.

3.1 Local projections

We use a local projections framework (Jordà, 2005) to study how an SME’s cash position going into the crisis affects its investment during and after the crisis.¹³ Local projections allow us to estimate how a firm’s investment over horizon $j > 0$ responds to the financial crisis conditional on the firm’s pre-crisis cash position relative to its rivals. As the global financial crisis was unexpected, it is unlikely that firms were hoarding cash prior to the crisis in anticipation of a credit supply shock that would affect their ability to invest once the crisis hit.

We regress fixed asset growth of firm i between 2007 and horizon j on the firm’s initial cash position and a number of control variables. We estimate the following regression model:

$$\Delta \ln FA_{i,07+j} = \beta_j \text{Relative cash}_{i,06} + \gamma_j X_i + \sum_{k=0}^1 \theta_{kj} \Delta \ln FA_{i,07-k} + \rho_s + \vartheta_r + \varepsilon_{i,j} \quad (1)$$

where i indexes the firm and j the horizon over which fixed asset growth is measured. We set j to range from one to seven years to study firms’ fixed asset growth up to 2014. $\Delta \ln FA_{i,07+j}$ is defined as the log difference of fixed assets between 2007 and year 2007+ j . *Relative cash* captures the firm’s cash holdings in 2006 relative to other SMEs active in narrowly defined 4-digit industries using z -scores. γ_j is a coefficient vector and X_i is a matrix of firm-level control variables that might affect a firm’s investment decisions and correlate with its cash position. This includes two age dummies, *Mature* and *Old*, the *Group* dummy, *Size* defined as the log of total assets, *Leverage* measured as total liabilities over total assets and *Profits* which equals profits over total assets. All these control variables are measured in 2006. In addition, we control for pre-crisis annual fixed asset growth between 2005 and 2006 and between 2006 and 2007. In an extension of the model, we also include turnover growth over these years as control variables. ρ_s is a vector of 4-digit industry fixed effects, ϑ_r is a vector of regional fixed effects, and ε_{ij} is the error term at horizon j .

Regressions are estimated for each horizon separately using OLS and standard errors are clustered at the 4-digit industry level. As we estimate a separate regression for each horizon,

¹³Local projections have several advantages over computing impulse responses using vector autoregressions (VAR). They can be estimated by simple regression techniques, they are more robust to misspecification, analytical inference is simple and they can easily accommodate non-linearities and multiple fixed effects (Jordà, 2005).

including industry and region fixed effects is akin to including industry-year and region-year fixed effects in a panel regression. These fixed effects thus absorb all demand and productivity shocks at the industry and regional level that can affect a firm’s investment decisions throughout the crisis and its aftermath. We focus on a sample of surviving SMEs to ensure that changes in cash-investment sensitivities across different horizons are not driven by firm entry or exit.

The main coefficients of interest in Equation 1 are the β_j coefficients. Our estimates for β_j measure the sensitivity of firms’ investment over horizon j to their cash holdings before the onset of the crisis. A positive estimate for β_j implies that fixed assets of firms with larger initial cash holdings grow more over horizon j . Because of the dynamic nature of the coefficients, we will present the regression results as graphs and plot our estimates of β_j over horizons $j = 1, \dots, 7$.

We estimate a similar model for the pre-crisis period in order to examine whether cash-investment sensitivities differ for crises periods and non-crises periods when financial conditions are looser. For this exercise *Relative cash* captures the firm’s cash holdings in 2000 and the dependent variable $\Delta \ln FA_{i,01+j}$ is defined as the log difference of fixed assets between 2001 and year $2001+j$.¹⁴ We set j to range from one to six years and study firms’ fixed asset growth up to 2007. We choose a horizon of six rather than seven years to ensure that our pre-crisis analysis does not overlap with the crisis period. The control variables are the same as in Equation (1) and are measured in 2000, except for *Pre-Investment* which is defined as annual fixed asset growth between 1999 and 2000 and between 2000 and 2001. We focus only on the set of SMEs which were active over the full pre-crisis period.

3.2 Identification using a sample of firms with volatile cash holdings

Identifying the causal effect of cash holdings on investment is challenging. Even though our regression model explicitly controls for a rich set of firm characteristics, unobserved confounding factors could still bias our estimates for β_j . For example, firms might hoard cash in anticipation of future investment opportunities. In addition, unobserved characteristics of firms’ managers or owners could affect both cash holdings and investment decisions during and after a financial crisis. A priori it is not obvious, however, how large the bias is and whether it is positive or negative.

Isolating exogenous variation in cash holdings is challenging, particularly when it must be done at a precise point in time (in our case, just before the global financial crisis). An approach most often used in the literature is to estimate a firm’s “excess cash”, i.e. the amount of cash a firm holds in a given year in excess of what it likely needs to run its daily operations and finance its investments (see for example Duchin, Ozbas and Sensoy, 2010, Opler et al., 1999 and Dittmar and Mahrt-Smith, 2007). However, the use of excess cash seems to be a more

¹⁴The distribution of cash holdings at the 4-digit industry level is very similar in 2000 and in 2006.

convincing identification strategy for large corporates than for SMEs given that only basic balance sheet information is available for the latter.

We therefore propose an alternative identification strategy which exploits the empirical regularity that for a significant number of UK SMEs, cash holdings exhibit a very low correlation year-on-year (Figure 2). Cash holdings of these SMEs appear to be primarily driven by variation in sales, production patterns and resulting cash flows. For such firms, it is less plausible that cash holdings at the onset of the crisis were correlated with unobserved characteristics such as for example prudent management or long-term investment opportunities. Furthermore, a large shock like the global financial crisis likely weakened the correlation between anticipated investment opportunities and actual investment opportunities, particularly in the short run. Even if SMEs with volatile cash held cash prior to the crisis for investment purposes, it is unlikely that such opportunities remained viable or desirable during the crisis. Estimating our regressions for this subset of SMEs should therefore reduce any positive or negative bias of β_j . More generally, this identification strategy has the advantage of minimal data requirements, easily interpretable coefficients on cash holdings and flexibility to study different time periods or institutional environments.

To identify firms with volatile cash holdings, we calculate the auto-correlation coefficients of cash-to-asset ratios between the first year of our dataset until the onset of the crisis for each firm. The distribution of auto-correlation coefficients is shown in Figure 2. Auto-correlation coefficients close to zero indicate that past cash holdings are less informative about current cash holdings. We define cash holdings as volatile if the auto-correlation coefficient takes a value between -0.3 and 0.3. Using this definition we categorize a subset of 60,977 SMEs as having volatile cash holdings. Since these thresholds are somewhat arbitrary, we experiment with different bands and also present results using a laxer and narrower definition of volatile cash holdings based on a sample of firms with auto-correlations between -0.4 and 0.4 and between -0.2 and 0.2.

As the summary statistics in Table 1 show, (relative) cash holdings and other balance sheet variables of SMEs in this subset are very similar to those in the full set of firms. SMEs in this subset are however somewhat larger and significantly older. This is due to the fact that the auto-correlation coefficients for cash ratios are calculated over the period leading up to the financial crisis. Therefore, SMEs that we identify as having volatile cash are firms for which a long time series of cash holdings is available and these firms tend to be larger and older.

A comparison of initially cash-rich and cash-poor SMEs with volatile cash holdings suggests that they do not differ significantly in terms of their other characteristics. Table 2 shows the means, variances and normalized differences of characteristics of firms in the top and in the bottom quartile of the relative cash distribution. On average, cash-rich firms tend to be smaller, slightly younger, less leveraged and slightly more profitable. Their average pre-crisis investment is very similar to the investment of cash-poor firms. Normalized differences in means suggest

that cash-rich and cash-poor firms only differ significantly in terms of their leverage ratios. The latter is to some extent a consequence of splitting the sample based on firms' liquid asset ratios. While focusing on a sample of SMEs with volatile cash holdings mitigates endogeneity bias, we prefer to show these results alongside our estimates for our full sample which is more representative of the SME population in the UK. Older and larger firms tend to be less financially constrained and therefore less dependent on internal sources of funds. As we show in Section 4.4.1, this affects the magnitude of the cash effect. Furthermore, given that data are only available from 1999, we could not identify a subset of SMEs with volatile cash holdings for our pre-crisis sample which focuses on investment from 2001 onwards. Comparing our results for the global financial crisis with those for the pre-crisis period is vital for understanding if cash-investment sensitivities change during downturns.

4 Long run effects of cash on investment

In this section, we examine whether a firm's pre-crisis cash position relative to its industry rivals affected its investment during the financial crisis and whether the impact was amplified during the recovery period.

4.1 Investment and cash during the global financial crisis and its aftermath

Figure 4 graphically presents the results from the local projection regressions as specified in equation (1). The solid lines depict the β_j estimates for each horizon. The two dotted lines indicate the 90 percent confidence intervals. The panel on the left shows the estimates for the full sample of firms. The positive and significant coefficient estimates for the first two horizons indicate that firms with high cash holdings going into the crisis experienced higher growth in their fixed assets relative to their cash-poor rivals during the crisis. This is in line with the findings of a positive impact of cash on investment for publicly listed firms in the US (Duchin, Ozbas and Sensoy, 2010). Our findings are also in line with those of Berg (2018) and Beck, Da-Rocha-Lopes and Silva (2021) who show that firms with cash at hand reduce investment less in the short-term when faced with a credit supply shock.

Our findings show that focusing exclusively on the crisis episode itself can underestimate the impact of a financial crisis on investment. The coefficient continues to be positive after the crisis and even increases over the recovery period. The positive impact of high cash holdings is not only persistent but is amplified over time. This suggests that SMEs with relatively high levels of cash prior to the crisis continued to invest more than their low-cash rivals even when the crisis subsided, credit became more readily available and demand returned. In the panel

on the right, we extend the model and also control for the pre-crisis performance of firms as captured by their turnover growth in the two years prior to the crisis. This significantly reduces the sample which now only includes 27,428 medium-sized enterprises. The coefficients in Figure 4 (right hand side panel) are similar to the baseline regressions, and we also find the strong amplification effect over longer horizons.¹⁵

Figure 5 graphically illustrates the economic magnitude of these results. The figure shows the implied difference in cumulative fixed asset growth between cash-rich and cash-poor firms during the crisis (2007-2009) and during the crisis *and* the subsequent recovery period (2007-2014) using the estimates from the baseline model. We define cash-rich firms as firms at the 90th percentile of the relative cash distribution and cash-poor firms as firms at the 10th percentile. Taking the average across all industries, we estimate that the cash-rich firm kept its stock of fixed assets between 2007 and 2009 constant. Hence, the cash-rich firm was able to replace its fixed assets that had depreciated during the crisis, i.e. its gross investment was positive, but its net investment was zero. The fixed assets of the cash-poor firm decreased by 4.9 percent instead; a difference of close to 5 percentage points. By 2014 the cash-rich firm had increased its stock of fixed assets by 4.4 percent, while the cash-poor firm had decreased its fixed assets by 7.4 percent. This means that the difference in investment more than doubled during the recovery period to 11.8 percentage points.

In Appendix Figure 1 we provide supplementary evidence on how initial cash holdings affected investment year on year. This gives us insights into the period over which cash-rich SMEs experienced higher annual investment rates compared to cash-poor SMEs. We find that the investment rate of cash-rich SMEs is significantly higher compared to that of cash-poor SMEs until 2013. The difference in annual investment rate peaks around 2009 but stays very similar in magnitude until 2011, after that the differential effect slowly declines. By 2014, the annual investment rates of cash-rich and cash-poor do not differ anymore.

To mitigate endogeneity concerns, we re-estimate equation (1) for the subset of SMEs with volatile cash holdings. As before we find that the cash coefficient is positive and significant for the investment horizons 2007-2009 and that the investment gap increases over time (Figure 6). The estimates are somewhat smaller compared to those of the full sample. This could be due to a sample selection issue (e.g. firms in this sample are on average older and larger) or due to a reduction in the bias of the estimated cash coefficient. When we vary the definition of volatile cash holdings, using narrower (auto-correlation coefficients of cash-to-asset ratios between -0.2 and 0.2) and broader (auto-correlation coefficients between -0.4 and 0.4) bands for auto-correlation coefficients, the results are very similar.

¹⁵We also experimented with adding turnover volatility (measured as the standard deviation of turnover relative to total assets between 2000 and 2006) as a proxy for risk as another control variable. The results are materially the same, but the sample halves and turnover volatility is insignificant so we decided not to include it. Results are available upon request.

4.2 Investment and cash in the pre-crisis period

Next, we examine whether the amplification effect is a distinct feature of the financial crisis and its aftermath (henceforth called "crisis sample" or "crisis period") by estimating a similar model for the pre-crisis period (2001-2007). The results shown in Figure 7 are striking. Contrary to our estimates for the 2007-2014 period, the β_j -coefficients for the pre-crisis period are significant at the 10 percent level for the first two years and become (mostly) insignificant thereafter. Furthermore, the coefficients for the pre-crisis sample are much smaller than (and statistically different from) the coefficients for the crisis sample and the amplification effect that we document for the crisis period is absent during the pre-crisis period.

A potential concern with this analysis is that firms in the crisis sample could be different from those in the pre-crisis sample. To ensure that this is not driving our results, we rerun our regressions for the subset of firms that are included in both the pre-crisis and the crisis sample. The estimates for β_j using the fixed sample in the right-hand side panel of Figure 8 are similar to those for the full samples, except that the coefficients for the fixed sample are smaller for each investment horizon. As we will explore further in Section 4.4.1, this is likely due to the fact that the fixed sample contains mostly older SMEs, which tend to be less financially constrained and therefore less reliant on internal funds for investment.¹⁶

Figure 8 graphically illustrates the difference in long-term investment behavior between cash-rich and cash-poor SMEs during the pre-crisis and crisis periods using the estimates of the baseline model. Based on the estimated β_j -coefficient for the 6th horizon (the last horizon for our pre-crisis sample), we find that in the pre-crisis period a cash-rich firm increased its stock of fixed assets by 4.7 percent and a cash-poor firm by 3.2 percent. The difference between the two was 1.5 percentage points and statistically insignificant. By contrast, over the period 2007-2013 a cash-rich firm grew its stock of fixed assets by 3.1 percent, while a cash-poor firm shrank its stock by 8.7 percent. Hence, the difference in fixed asset growth amounted to 11.8 percentage points. This shows that the difference between the two periods is mainly driven by the behavior of cash-poor firms: While initially cash-poor firms increase their fixed assets over the long-run in normal times, they reduced their fixed assets in crisis times instead.

Overall, these results suggest that the tight financial conditions played an important role in driving the persistent cash-effect that we document for the crisis period.

4.3 Publicly listed firms

We now turn to our sample of publicly listed firms. The results from estimating equation (1) for publicly listed firms are shown in Figure 9. Consistent with Duchin, Ozbas and Sensoy (2010)

¹⁶Another potential concern is that the start of pre-crisis period coincides with the aftermath of the dot-com crash. We show in Appendix Figure 1 that results are similar if we use 2002 or 2003 as base years instead.

who study publicly listed firms in the US, we find that publicly listed UK firms with large cash holdings invested more in the first year of the crisis, relative to their cash-poor counterparts. This differential effect is still present in the second year of the crisis, but it disappears during the recovery phase. It turns out that the persistence of the cash-effect is not only unique to post-crisis periods, but also unique to SMEs.

We attribute the lack of persistence for publicly listed firms to two factors. First, the crisis had a much smaller impact on investment of cash-poor publicly listed firms. While cash-poor SMEs had to reduce their fixed assets by 4.9 percent, cash-poor publicly listed firms could keep their stock of fixed assets constant between 2007 and 2009. They did not lose productive capacity as a result, reducing the likelihood of self-reinforcing feedback loops setting in. The finding that cash-poor listed firms were able to maintain their fixed assets is consistent with credit conditions tightening less for listed firms (Chodorow-Reich, 2014). Even though credit conditions deteriorated, large firms could draw down existing credit facilities, crowding out lending to smaller firms (Chodorow-Reich et al., 2022, Greenwald, Krainer and Pascal, 2020). They could also tap the bond markets during the crisis to supplement bank credit (Adrian, Colla and Shin, 2012; Becker and Ivashina, 2014).

Second, when the recovery set in, credit conditions improved faster for publicly listed firms than for SMEs. After the crisis subsided, banks remained pessimistic about economic conditions and loan performance which impeded credit recovery, particularly for small and bank-dependent firms (Falato and Xiao, 2022; Ma, Paligorova and Peydro, 2022). Data from the Credit Conditions Survey for the UK suggest that the cost of credit for large firms and to a lesser extent medium-sized firms fell almost immediately after the global financial crisis. On balance, lenders reported that for smaller firms credit conditions only started to improve in 2013. Easing credit conditions allowed large, cash-poor firms to circumvent the negative feedback loop by financing investment and growth with external funds while this was not an option for cash-poor SMEs.

Our findings show that balance sheet conditions at the onset of a crisis have different long-term implications for the recovery of SMEs and publicly listed firms. Unlike for publicly listed firms, the cash effect persists for SMEs because initially cash-poor SMEs on a downward trajectory enter a self-reinforcing feedback loop that they cannot exit by accessing external finance. In Section 5 we explore three mechanisms that can explain the persistence of the cash-effect.

4.4 Cross-sectional analysis

To provide additional evidence that a tight of credit conditions are a key driver of our results, we exploit cross-sectional firm and industry heterogeneity.

4.4.1 Firm-level

We first analyze variation in firms' access to external finance using firm-level measures. If liquid assets were beneficial because financial conditions deteriorated during the crisis, this effect should be larger for those SMEs that were more likely to be affected by a reduction of banks' credit supply. We use the age and the size of a firm to proxy for financial constraints at the firm-level. Younger and smaller firms require more lender screening and monitoring compared to larger and older firms, as they tend to be more opaque. Within the group of SMEs, younger and smaller firms should therefore have been more affected by a tightening of financial constraints (Almeida, Campello and Weisbach, 2004, Iyer et al., 2014).

First, we split our crisis sample into young firms (less than 10 years old in 2006) and old firms (20 years or older in 2006) and estimate the regressions for the longest horizon, i.e. we use fixed asset growth between 2007 and 2014 as the dependent variable. The results are presented in the upper panel of Table 3. On the left-hand side we present the results for our full SME sample and on the right-hand side we show results for the subset of SMEs with volatile cash positions. For both firm samples, the cash coefficients are significantly larger for young firms. Focusing on the full SME sample, a young and cash-rich SME had increased its stock of fixed assets by 15.9 percentage points more than a young and cash-poor firm by 2014. For old SMEs, this difference was only 6.2 percentage points.

Next we split our sample of SMEs into small firms (firms in the lowest quartile of the size distribution) and medium-sized firms (firms in the highest quartile of the size distribution). The results (Table 3, lower panel) show that the cash–investment sensitivities for the full and the volatile samples over the horizon 2007-2014 are larger for small firms. Differences between SMEs of different sizes are somewhat less pronounced than differences between SMEs of different ages: The difference is statistically significant at the 1 percent level for the full sample, but insignificant for the sample of SMEs with volatile cash holdings. The weaker differential effects for firm size are in line with earlier findings in the literature that show that firms are more likely to face financial constraints earlier in their life cycle when they typically lack stable cash flows and a credit history (e.g. Haltiwanger, Jarmin and Miranda, 2013; Cloyne et al., 2023). Focusing on the full set of SMEs, a small and cash-rich firm grew its stock of fixed assets by 22.8 percentage points more by 2014 than a small and cash-poor firm. For medium-sized firms, this difference was only 10.7 percentage points.

4.4.2 Industry-level

We now exploit industry heterogeneity in our dataset. First, we identify sectors in which firms likely became more financially constrained during the crisis. If cash holdings provide a firm with a strategic advantage when credit conditions deteriorate, the impact of cash should be larger in industries where a firm's rivals face more difficulties obtaining external funds during the

crisis. As argued previously, firms that are small or young are more likely to become financially constrained during a crisis. We therefore expect a firm's cash holdings to have a bigger impact on its long-term investment if it operates in an industry where other firms tend to be small or young.

To test this, we follow Fresard (2010) and measure financial constraints affecting a firm's rivals as the mean size and the mean age of firms in its 4-digit industry in 2006.¹⁷ We then rank the industries based on each of the two variables and identify firms in the bottom and top quartile of the industry distributions. For each industry characteristic we estimate equation (1) separately for firms in the bottom and the top quartile and compare the cash-investment sensitivities for the longest horizon, i.e fixed asset growth between 2007 and 2014.

The results in Panel A of Table 4 are in line with our predictions. For both industry characteristics, we find that the long-term effect of cash is larger when the firm's rivals are more likely to face tighter financial constraints. The cash coefficient is positive and significant at the one percent level in industries where firms tend to be small or young. The cash coefficient is also significant in industries where rivals are older or larger, but the effect is much smaller. Cash coefficients for firms operating in industries in the top and bottom quartile of the age and size distributions are significantly different from each other in the full sample. If we constrain the sample to firms with volatile cash holdings, coefficients become somewhat smaller and the difference is less pronounced. This is in line with the fact that the firms in this sample are larger and older which makes them less reliant on cash holdings for investment.

Other industry characteristics might also affect cash-investment sensitivities. We investigate these in panel B of Table 4. First, we examine whether the capital intensity of an industry matters. We capture this by averaging the fixed asset to total asset ratio across firms within a 4-digit industry in 2006 and compare firms in the top and bottom quartile of the industry distribution. The results indicate that the cash-investment sensitivity is somewhat higher for firms in capital intensive industries, but the difference is statistically insignificant for both subsets of firms.

The fierceness of competition a firm faces in an industry could also determine how beneficial cash is. Using firm-level turnover data from the Office for National Statistics (2017), we calculate the Herfindahl-Hirschman Index (HHI) for each industry at the 4-digit level in 2006. The HHI can range from 0 to 1, where a higher index indicates that an industry is more concentrated. We do not take a stance on how high or low the HHI should be for an industry to be concentrated or competitive but compare firms in the bottom quartile to those in the top quartile of the industry HHI distribution instead. We find that cash has a positive impact on firm investment in both concentrated and competitive industries. The coefficient is somewhat larger for firms

¹⁷Results are very similar if we use the median age and size.

operating in concentrated markets, but the difference is again not statistically significant.¹⁸ ¹⁹

Finally, we examine if the extent to which an industry suffered during the crisis affected cash-investment sensitivities. A priori it is not obvious under which conditions cash would be more valuable. On the one hand, more opportunities to purchase fixed assets at discounted prices from failing or struggling rivals could arise in industries that were hit hard by the crisis. Furthermore, lenders were more likely to withdraw funding from these sectors, making cash even more valuable. On the other hand, investment opportunities of cash-rich firms in declining industries with weak demand might have been limited and very risky, reducing the strategic advantage of holding cash. To test which effect dominates, we measure the depth of the crisis at the 4-digit industry level based on the growth in industry value added between 2007 and 2010. The data are again from the ONS. When we compare firms in industries in the bottom quartile of the industry growth distribution with those in the top quartile, we find a positive cash effect in both subsamples but the difference in coefficients is not significant.

Overall, these results support the view that cash holdings provided firms with a strategic advantage over their cash-poor rivals which persisted during the recovery period. Cash benefited especially those firms that were active in industries where rivals' access to external finance deteriorated. Other industry characteristics mattered less.

4.5 Post-crisis investment and alternative cash measures

Our preferred cash measure is based on a firm's cash holdings relative to the cash holdings of other SMEs that are active in the same narrowly defined 4-digit industry. We calculate *Relative cash* using z -scores. It gauges the competitive advantage that an SME gains from holding cash. In this section, we examine whether our results are robust to using alternative measures of cash holdings.

We start by examining "excess cash", i.e. the amount of cash a firm holds in a given year in excess of what it likely needs to perform its daily operations and to finance its investments. Excess cash measures have been used extensively in the literature in order to address endogeneity concerns (see for example Duchin, Ozbas and Sensoy, 2010, Opler et al., 1999 and Dittmar and Mahrt-Smith, 2007). An estimate of firms' "normal" cash needs is obtained by regressing cash on a number of balance sheet characteristics which typically affect the amount of cash firms choose to hold. Excess cash is the difference between a firms' predicted cash holdings and their actual cash holdings.

We follow the approach of Duchin, Ozbas and Sensoy (2010) and Dittmar and Mahrt-Smith (2007) to determine how much cash a firm would normally be expected to hold given its balance

¹⁸Results are very similar when we use a measure of HHI based on employees.

¹⁹Note that even in concentrated markets, often significant competition exists between small firms that compete locally. A case in point is the grocery store industry which is dominated by a few large supermarket chains, but in which many small corner stores compete with each other.

sheet characteristics but adapt the methodology to SMEs for which we do not observe several variables that are available for larger firms. Our cash regressions control for firm size and age to capture a firm’s access to external finance. The availability of cash substitutes is captured by working capital (net current assets minus cash). The cash regression also includes past investment, the growth rate of cash balances, total liabilities and cash flow as proxied by a firm’s profit, and controls for firm and (4-digit) industry-year fixed effects. We estimate this for the period 2000-2006 for the sample of firms which are also included in our crisis regressions. The residuals from the regression for the year 2006 capture firms’ excess cash holdings. The results are presented in Table 5. In line with our previous evidence, we find (for both samples) that excess cash had a positive effect on fixed asset growth during the crisis (column (1)) and that this effect was amplified during the recovery period (column (2)). This suggests that excess cash, despite being potentially expensive to hold in normal times, can have important long-term benefits when the credit cycle turns.

Next, we show that our results are robust to using two additional measures of cash. First, we use simple cash-to-asset ratios which are not z-scored. The results in columns (3) and (4) show that our results continue to hold for both samples. Second, we measure relative cash in 2007 instead of 2006. UK firms are not required to submit their accounts during a specific month of the year although most firms submit their accounts at the end of the calendar year or at the end of the fiscal year at the beginning of April. We assign accounts submitted in the first half of a year to the previous calendar year and reports submitted in the second half of a year to the current calendar year. This implies that accounts submitted until June 2007 are assigned to the year 2006 and are thus included in our original, pre-crisis cash measure. Problems in the UK financial sector already emerged in the summer of 2007 which led to the run on Northern Rock. Measuring a firm’s cash holdings prior to this event therefore reduces concerns that firms were hoarding cash in anticipation of a credit supply shock. However, one could argue that our cash measure for 2006 does not fully capture cash holdings at the onset of the crisis as the crisis only really took hold in 2008. Therefore, we examine whether our results are robust to measuring relative cash in 2007. The results in columns (5) and (6) show that this is the case for both samples.

5 Mechanisms

In the previous section, we documented the emergence of an investment gap between cash-rich and cash-poor SMEs during the crisis which was amplified during the recovery period. In this section, we explore three mechanisms that can potentially explain the worsening of the relative position of cash-poor firms during the recovery period: competition dynamics, borrowing constraints and precautionary savings.

5.1 Competition dynamics

First, we examine whether a change in competition dynamics is a possible driver behind the widening investment gap. Due to their ability to invest during the crisis, cash-rich SMEs were able to preserve their productive capacity. At the same time, the productive capacity of cash-poor SMEs declined. Thus, even if demand falls during a crisis, cash-rich firms may be able to expand their market share and improve their competitive position. They can advance their position even further if they can acquire assets at discounted prices from their struggling competitors or if their presence deters other firms from entering or investing (Benoit, 1984). In addition, they can invest in competitive strategies at the expense of cash-poor rivals, such as investing strategically in R&D, the location of stores and plants, distribution networks or advertising (Campello, 2006). Cash reserves may also allow firms to strategically lower their prices to capture market share from vulnerable competitors that have to maintain or increase their prices to generate sufficient cash flow (Gilchrist et al., 2017).

When the recovery sets in and demand rebounds, SMEs that were able to invest and capture market share during the crisis are in a better position to meet demand. This may give them the opportunity to increase their earnings and strengthen their balance sheets further, allowing them to keep investing and to capture even more market share. Firms that were cash-poor at the onset of a crisis may struggle to catch up with their cash-rich rivals and may continue to see their positions weaken. As a result of these feedback effects, the initial shift in competition dynamics during the crisis can be reinforced during the recovery phase.

In order to assess whether there is evidence in favor of the mechanism outlined above, we test how pre-crisis cash holdings affected firms' market shares and performance during the crisis and the recovery phase. To capture a firm's market share we divide the firm's assets by the sum of total assets in its 4-digit industry. This competition measure assumes that the firm competes with firms across the UK. In addition, we compute a measure of local competition, exploiting the idea that SMEs in non-tradable industries typically compete locally and mainly rely on local demand. We adopt the approach of Mian and Sufi (2014) and categorize retail firms and restaurants as non-tradable sectors. Using firms' postcodes, we identify the local market in which firms in non-tradable sectors operate. We capture "local market shares" by dividing a firm's assets by the sum of total assets of SMEs that operate in the same postcode area and 4-digit (non-tradable) industry.

Finally, we examine firm performance to assess whether having cash enabled firms to generate higher earnings that could be reinvested. We proxy for this using cumulative profits scaled by total assets in 2007, and using average return on assets (as measured by profits over total assets) over the respective time horizon. As for our market share variables, we examine firm performance for all industries and for non-tradable sectors only.

To assess how a firm's cash position affects the growth rate of its (local) market share and its

performance, we estimate a model similar to our baseline specification (1) but replace fixed asset growth with the new dependent variables:

$$\Delta Y_{i,07+j} = \beta_j \text{Relative cash}_{i,06} + \gamma_j X_i + \sum_{k=0}^1 \theta_{kj} \Delta Y_{i,07-k} + \rho_s + \vartheta_r + \varepsilon_{i,j} \quad (2)$$

where $\Delta Y_{i,07+j}$ is the firm's (local) market share growth or profit between 2007 and year 2007+j. Similar to regression model (1) we control for the firm's size, age, leverage, profit and whether it is part of a group, and we include pre-crisis values of the respective dependent variables (one and two periods lagged).²⁰ In the market share regressions we only include region or post-code area fixed effects as the dependent variable is a relative-to-industry variable and hence all industry-specific factors are already removed. In the performance regressions, we include 4-digit industry and region or postcode area fixed effects. Regressions are estimated for the different horizons separately using OLS and standard errors are clustered at the 4-digit industry level. Our sample includes only SMEs with data on relative cash, the control variables and the respective dependent variable for all horizons to ensure that changes in the parameter over time are not driven by sample selection issues.

In Table 6 we present the estimates for each dependent variable for the direct crises period (2007-2009) and the crisis and recovery period combined (2007-2014). The left hand side (columns (1) - (4)) shows results for the full set of firms and the right hand side (columns (5) - (8)) for the subset of firms with volatile cash holdings. For both samples we find that SMEs with high levels of cash going into the crisis grew their market share more during the crisis and this effect became larger during the subsequent recovery period (columns (1) - (2) and (5) - (6)). We document a similar amplification effect for our local competition variable, with two notable distinctions (columns (3) - (4) and (7) - (8)). The cash-effect is insignificant during the crisis, but the amplification effect is significantly larger. Two factors can potentially explain this. One, our local competition measure is more precise and therefore could more adequately capture changes in competition dynamics. Second, retail and hospitality were strongly affected by the financial crisis making it difficult to capture market share during the height of the crisis. However, as soon as the recovery phase set in and demand returned, cash-rich SMEs in these sectors were able to quickly take advantage of it.

Turning to performance, we find that having cash at hand when the credit cycle turned also positively affected firms' cumulative profits (Panel B) and their average return on assets (Panel C). Our finding that the cash-effect becomes larger for all dependent variables when we take the recovery period into account points to a self-reinforcing feedback mechanism. Reassuringly, the effects are very similar when we include all sectors and when we focus solely on non-tradable sectors. They are also similar for both sets of SMEs.

²⁰In the regressions where cumulative profits and ROA are the dependent variables the lagged dependent variables are included in the regression and profit is excluded as a control variable.

It is challenging to measure competition accurately. First, industrial classifications usually group firms based on the similarity of their production processes, rather than the intensity of the product market competition between firms. Second, it is often difficult to determine which geographical market the firm competes in. Finally, we do not have information on sales for most firms in our sample and therefore measure market shares in terms of total assets. Nevertheless, our findings are consistent with the idea that cash buffers allowed firms to maintain their productive capacity during the crisis which gave them a competitive edge. When the recovery set in, initially cash-rich firms could invest more compared to their rivals and further improve their competitive position.

Our evidence that changes in competition dynamics is one of the potential mechanisms that drove the widening of the investment gap is related to the work of Fresard (2010). Fresard (2010) shows that cash holdings enable publicly listed US firms to capture market share after a shock to industry competition. We extend his work by showing that having cash at hand provide SMEs (but not publicly listed firms) with a long-term advantage after a credit supply shock.

5.2 Borrowing constraints

Another driver behind the amplification effect that we document can be persistent differences in access to external finance by cash-rich and cash-poor firms during the crisis and recovery period. When credit conditions tighten during financial crises and vulnerabilities of the banking sector are exposed, SMEs are particularly affected as they tend to be more reliant on bank lending. They are also riskier and more opaque than large firms and therefore have more difficulties accessing credit when a flight to quality sets in ((Iyer et al., 2014; Cingano, Manaresi and Sette, 2016). Furthermore, banks tend to exercise more discretion when setting loan terms for smaller firms while large firms benefit from pre-committed credit lines (Chodorow-Reich et al., 2022). This makes loan supply for SMEs more sensitive to bad news and a worsening of repayment prospects. Furthermore, collateral constraints tighten when a financial crisis hits leading more firms to become financially constraint (e.g Kiyotaki and Moore, 1997; Khan and Thomas, 2013). This disproportionately affects SMEs as their loans are more often collateralized compared to those of larger firms (Chodorow-Reich et al., 2022). In fact, in the UK around 75-80% of SME loans are collateralized (Bahaj, Foulis and Pinter, 2020).

Corporate cash buffers can mitigate these effects when the shock hits. Larger cash balances protect a firm's net worth and, all else equal, make it less risky for banks to continue to lend. Hence, cash-rich SMEs more likely maintain access to credit on affordable terms during a crisis and can use these funds to finance investment. Furthermore, it is more likely that they can roll over their debt, thus freeing up cash flow that can be used for investment instead of repayments. By contrast, cash-poor SMEs are more likely to face binding borrowing constraints and may

therefore have to reduce their stock of fixed assets.

These differences in borrowing constraints faced during the crisis can propagate when the recovery sets in. First, as cash-rich SMEs grow their stock of fixed assets which can be pledged as collateral, their borrowing constraints likely ease over time.²¹ Initially cash-poor firms, whose stock of fixed assets declines, likely see their collateral constraints tighten further as time passes. Second, the ability to invest allows cash-rich SMEs to generate higher cash flow and profits compared to their cash-poor rivals (see Section 5.1). To the extent that banks take firms' recent earnings histories into account when extending loans (Ivashina, Laeven and Moreno, 2022; Lian and Ma, 2021) this also makes it easier for cash-rich firms to borrow. These effects are further enhanced if banks emerging from the crisis with weaker balance sheets and facing tighter regulation, apply more conservative lending standards during the recovery period. In other words, the gradual easing of credit conditions observed during the recovery period may not have benefited initially cash-poor SMEs, making it increasingly harder for them to break the negative feedback loop and to catch up with their cash-rich rivals.

To assess whether differences in access to credit by cash-rich and cash-poor firms could have been a driver behind the widening investment gap that we document, we first test if initial cash holdings affected the growth of firms' stock of debt over time. We estimate a model similar to regression model (2) but replace the dependent variable with log differences of corporate debt between 2007 and the year $2007+j$. We run separate regressions for three measures of debt: The first is a comprehensive measure of debt which includes trade credit, short term loans, overdrafts and long-term loans. The second focuses on the short-term component and includes trade credit, short-term loans and overdrafts. Finally, we test how cash affects the growth rate of long-term loans.²² We restrict our sample to the 20,906 SMEs for which we have information for all debt components for all years between 2007 and 2014, of those 7,242 have volatile cash holdings.²³

In Table 7 we present the estimates for the direct crises period (2007-2009) and the crisis and recovery period combined (2007-2014). Panel A shows the results for the full set of firms and panel B for the subset of firms with volatile cash holdings. We document a positive and significant impact of relative cash on debt growth for all three measures of debt during the crisis. In line with the hypothesis that after the crisis borrowing constraints affected initial

²¹In a previous version we showed that the growth in fixed assets is driven by growth in tangible assets. We do not detect a differential effect for intangible assets. Especially tangible assets can be used as collateral. See for theoretical and empirical contributions on the use of tangible and intangible assets as collateral for example Hart and Moore (1994); Shleifer and Vishny (2009); Sibilkov (2009); Rampini and Viswanathan (2010) and Falato et al. (2022).

²²Another interesting angle to explore would be the extent to which firms drew down their credit lines during the crisis (e.g Ivashina and Scharfstein, 2010; Acharya et al., 2021; Greenwald, Krainer and Pascal, 2020; Chodorow-Reich et al., 2022). Unfortunately, this information is not available in the dataset we use.

²³These tend to be larger SMEs. In unreported regressions we verify the existence of a persistent and growing investment gap between cash-rich and cash-poor SMEs for this subsample of SMEs as well (results available upon request).

cash-rich and cash-poor firms differently, we find that the cash-effect is amplified during the recovery period. Again the findings for the subset of volatile firms are very similar to those of the full sample, suggesting that our findings are not solely driven by unobserved factors that might correlate with SME cash holdings. We control for credit demand by including industry and region fixed effects. In unreported regressions we follow Degryse et al. (2019) and control for credit demand using industry-location-size fixed effects. This alternative demand control significantly reduces the sample, but results are reassuringly very similar (results available upon request).

It is possible that faster deleveraging by cash-poor firms is the result of lower credit demand rather than tighter borrowing constraints. As we do not have loan application data, we unfortunately cannot cleanly separate loan demand from loan supply. To provide more evidence on a supply side channel, we instead analyze changes in SMEs credit scores. Our credit score measure is the QuiScore provided by BvD. QuiScore is a propriety measure of creditworthiness developed by UK credit rating agency CIRF and is primarily used to rate smaller firms. The credit scores take both financial and non-financial information (directors' and shareholders' history, County Court Judgments etc.) into account. Credit scores range from 0 to 100, where 0 indicates that a firm is considered as a high credit risk and a score of 100 indicates that it is secure and stable.

To assess whether firms with higher initial cash holdings improved their credit scores more during and after the crisis, we regress the change in firms' credit scores between 2007 and the year $2007+j$ on relative cash, our firm control variables, and regional and industry fixed effects. Given that credit scores are not updated annually, and given that a firms pre-crisis credit score trajectory may be less relevant for its ability to weather the crisis than the level of the score, we control for the initial credit score at the onset of the crisis rather than lagged growth rates of the score.

The results are presented in the last two columns of Table 7. We find that during the crisis cash-rich SMEs experienced (minor) improvements in their credit scores while those of cash-poor SMEs deteriorated. The difference magnified again during the recovery period. If banks factor credit scores into their lending decisions, these findings suggest that initial cash-poor SMEs faced tighter borrowing constraints during the crisis and the recovery period.

5.3 Precautionary savings

The final mechanism that could potentially explain the persistence of the investment gap relates to precautionary savings that firms accumulate as an insurance against risks. Several papers have shown that firms tend to increase their cash reserves following large shocks due to heightened uncertainty, limited access to external finance, and the need for operational flexibility (Almeida, Campello and Weisbach, 2004; Song and Lee, 2012; Berg, 2018). These firms

choose balance sheet repair over investment in the short run (Xiao, 2019). For SMEs entering the crisis with very low cash reserves, prioritizing balance sheet repair over incremental investments might be crucial to prevent default.

When the recovery sets in and cash balances are higher, firms may wish to reverse this decision and start investing again, especially in light of adverse consequences of limited investment for their competitive positions. However, several factors might prevent firms from changing course. First, the lack of cash flow during the crisis might make it difficult to quickly build up cash holdings to the desired level. Second, the crisis might induce firms to permanently increase their optimal level of precautionary savings compared to the pre-crisis levels. In Europe uncertainty about the economic outlook remained high as the global financial crisis almost seamlessly morphed into the sovereign debt crisis. Furthermore, a shock as big as the global financial crisis generates a shift in risk perceptions from overly optimistic to overly pessimistic (Bordalo, Gennaioli and Shleifer, 2018). Third, it is possible that, guided by past experience, firms did not fully anticipate the negative feedback effects that building up cash reserves at the cost of lower investment would trigger. We have shown in Section 4.2 that during the pre-crisis period, lower short-term investment by cash-poor firms did not have long-term implications. On the basis of this experience, cash-poor SMEs might have underestimated the full, long-term cost of reducing investment during the crisis in order to build up cash buffers.

To examine whether the desire to increase precautionary savings could be another potential mechanism behind the persistence of the investment gap, we estimate a model similar to regression model (2) but replace the dependent variable with the log difference of cash holdings between 2007 and the year $2007+j$. In Table 8 we present the estimates for the direct crises period (2007-2009) and the crisis and recovery period combined (2007-2014). The left-hand side of the table shows the results for the full set of firms and the right-hand side for the subset of firms with volatile cash holdings.

We find, for both sets of firms, that cash buffers of cash-poor firms increased during the crisis relative to those of cash-rich firms and that this effect persisted during the recovery period. It is worth noting that while the percentage change in cash holdings for cash-poor SMEs is large, cash grew from a very low base. An SME in the 10th percentile of the relative cash distribution held only 1 percent of assets in cash at the start of the crisis, while an SME in the 90th percentile held 75 percent. Therefore while growth rates were high for cash-poor SMEs, the increase was small in absolute terms.

The results are consistent with the idea that during the downturn, cash-rich SMEs used some of their buffers to maintain their capital stock, while cash-poor firms chose to repair their balance sheets and to grow their precautionary savings. The persistent effect of initial cash is consistent with the fact that it can take a long time to build up cash reserves when cash flow and profits are low as was the case of cash-poor SMEs and may point to managers targeting higher liquidity ratios post-crisis, possibly due to increased uncertainty and changes to risk-perceptions.

Over time, cash holdings of initially cash-rich and cash-poor SMEs converged as cash-poor firms strengthened their safety net while cash-rich ones used their already large buffers for investment instead. This suggests that firms face a trade-off when credit conditions tighten. Increasing cash holdings today might reduce the probability of default. But improving the balance sheet by saving cash requires cutting back on investment and reducing productive capacity. Due to the resulting changes in competition dynamics and borrowing that we document this adjustment can have long-term consequences. Unlike publicly listed firms that could increase their cash holdings through increased borrowing (Xiao, 2019), cash-poor SMEs had to rely on their own (limited) cash flow instead. This again highlights the differences in adjustment mechanisms that apply to SMEs compared to large, publicly listed firms.

6 Firm survival

Up to this point we have focused exclusively on SMEs that survived the crisis and the recovery period. As a final step, we now examine whether cash holdings at the onset of a crisis affect the probability of firm survival. To examine whether initial cash holdings affect the probability of firm survival, we add SMEs to our sample that had entered the market before 2005 and were still active in 2007. We only include SMEs for which we have complete data for each year they are active. This leaves us with a total of 259,416 firms. We estimate a model similar to our baseline specification (1) but replace fixed asset growth with a survival dummy:

$$Survival_{i,07+j} = \beta_j Relative\ cash_{i,06} + \gamma_j X_i + \sum_{k=0}^1 \theta_{kj} \Delta Y_{i,07-k} + \rho_s + \vartheta_r + \varepsilon_{i,j} \quad (3)$$

where $\Delta Survival_{i,07+j}$ is a dummy which is one if the firm is active in year 2007+ j and zero otherwise.²⁴ Similar to regression model (1) we control for the firm's size, age, leverage, profit and whether it is part of a group, pre-crisis investment (one and two periods lagged) and industry and region fixed effects. Linear probability models are estimated for the different horizons separately using OLS and standard errors are clustered at the 4-digit industry level.

Figure 10 shows the results for the full sample of SMEs and for those with volatile cash holdings. For both samples we find that SMEs with higher initial cash have a significantly higher probability of survival during the crisis. By 2009 3.4 percent of the firms in our sample had exited. For cash-poor firms (those in the 10th percentile of the relative cash distribution) this number was significantly higher at 4.7 percent than for cash-rich firms (those in the 90th percentile) of which only 2 percent had exited. The cash-effect amplified until 2011. By then, 13 percent of the cash-poor SMEs had exited while only 8 percent of cash-rich ones did. From 2012 onward the cash-effect declines slightly and the coefficients are not significantly different

²⁴We thus maintain the same number of firms in each cross-sectional regression.

from the coefficient for survival up until 2011. Therefore, while initially cash-rich firms were more likely to have survived by 2014, this effect was driven by the positive impact of cash on survival prior to 2012.

This evidence complements our main findings on the investment of SMEs that survived both the crisis and recovery period and it again shows that the impact of balance sheet strength going into the crisis affects SMEs not only during the crisis, but in the recovery period as well.

7 Concluding Remarks

This paper documents a strong positive link between pre-crisis cash holdings and long-term investment of SMEs after the global financial crisis. SMEs with large initial cash holdings could continue to invest during the crisis while their cash-poor rivals had to divest. This gave cash-rich SMEs an advantage when the economy rebounded, resulting in a persistent investment gap which grew over the seven years following the shock. We do not observe a persistent effect of cash outside of crises episodes or for publicly listed firms, suggesting that access to external finance which would allow firms to break out of the feedback loop is crucial in driving these dynamics.

We present evidence consistent with three possible mechanisms that can explain the persistence and widening of the investment gap during the recovery period. The first mechanism relates to the ability of cash-rich SMEs to persistently outcompete their cash-poor rivals. We find that cash holdings at the onset of the crisis allowed firms to increase their market share and to generate more profits during the crisis, which could be reinvested, improving market shares and profits further during the recovery phase. The second mechanism is a cash-dependent tightening of borrowing constraints that contributed to the lower performance of cash-poor firms during the crisis, resulting in continued borrowing constraints during the recovery period even when credit conditions improved. We find that initially cash-poor firms deleveraged more during the crisis and experienced a worsening of their credit scores. Both these effects strengthened during the recovery period. The third mechanism is a desire to increase precautionary savings which started during the crisis but continued during the recovery phase, reflecting continued macroeconomic uncertainty, changes in risk preferences and a drawn-out adjustment process. In line with this, we find that initially cash-poor firms, which typically entered the crisis with very low cash holdings, grew their cash holdings in order to repair their balance sheets, while cash-rich SMEs reduced theirs and used their pre-crisis cash buffers and their retained earnings to fund investment.

Our findings have several implications. First, our analysis suggests that estimates of the impact of a crisis should take long-term effects into account. Focusing only on the crisis years can significantly underestimate the true effect of the shock, particularly if self-reinforcing dynamics amplify initial responses to a crisis. Second, our findings highlight the importance of

distinguishing between firms of different sizes to understand how different parts of the corporate sector adjust to shocks. Relying solely on evidence from publicly listed firms, which tend to benefit from looser financial conditions, can obscure our understanding of a vital part of the economy and can limit the effectiveness of policy interventions (see also Brunnermeier and Krishnamurthy (2020) in the context of Covid-19). Third, we find that cash-poor SMEs reduce their capital stock substantially during downturns. This highlights the importance of public lending schemes that help solvent firms bridge liquidity shortfalls. Well-designed support for the corporate sector can potentially prevent lasting damage to the economy's productive capacity after downturns.

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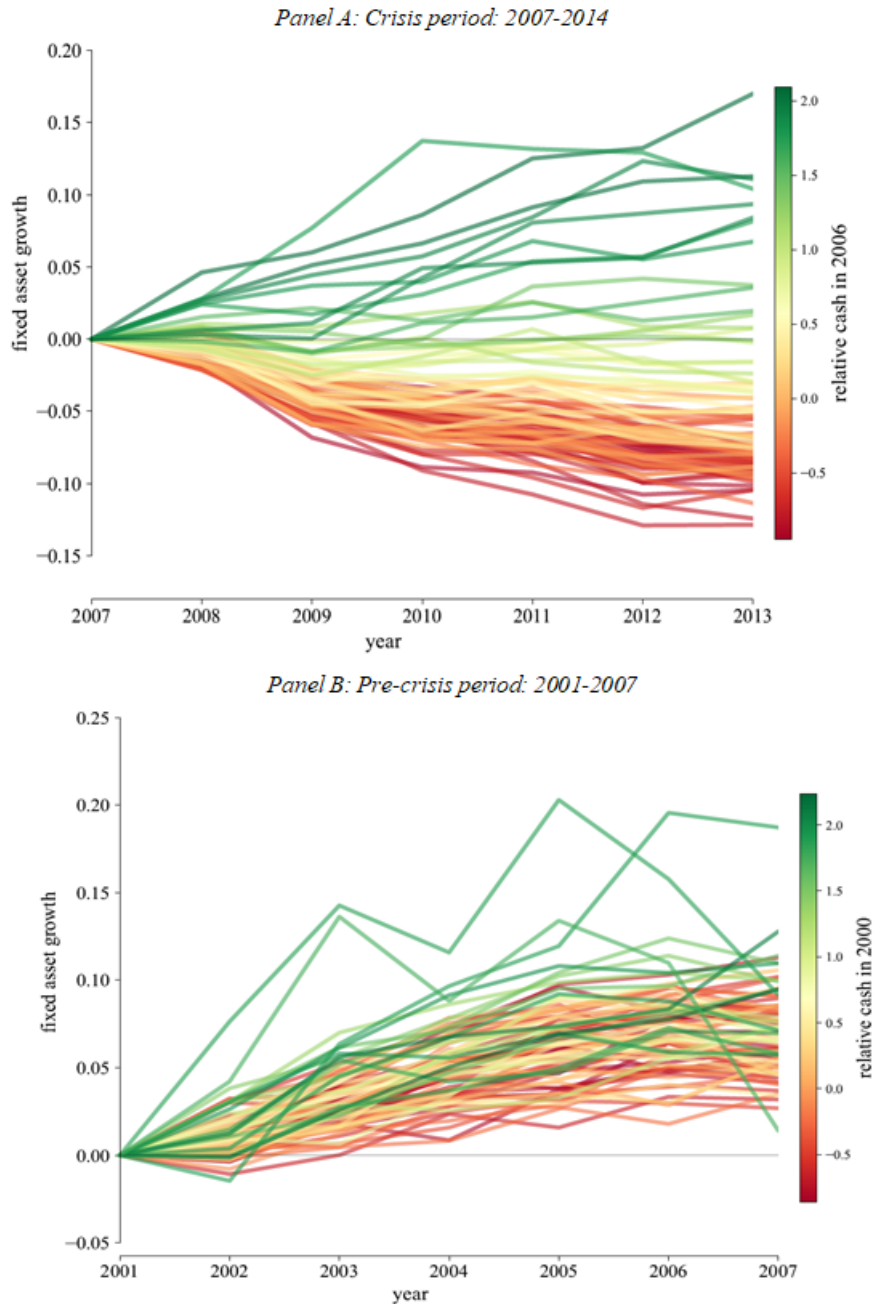
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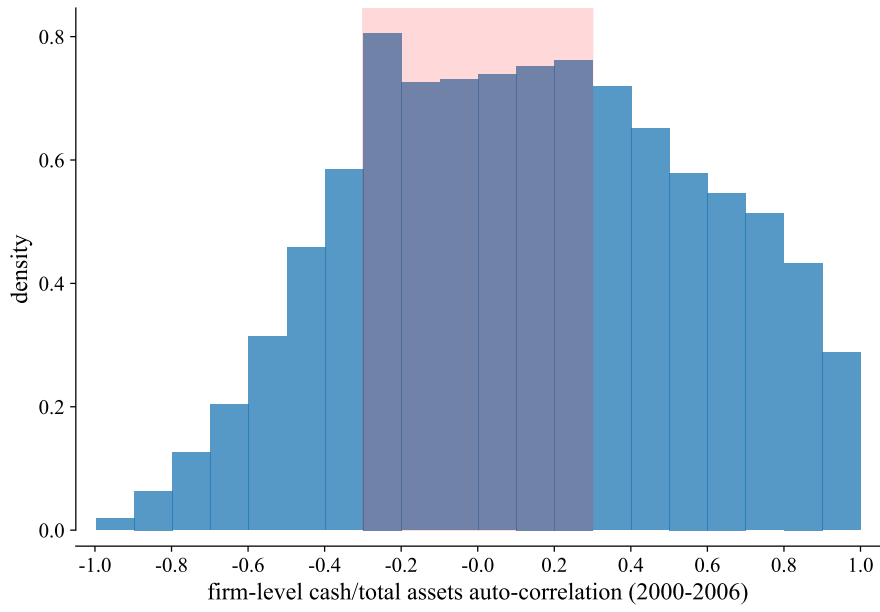
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Figure 1: Investment high vs low cash SMEs: crisis and pre-crisis period



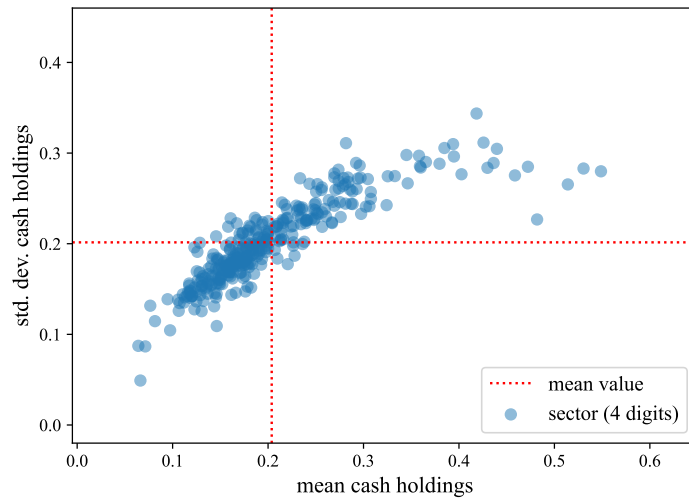
Notes: These figures plot the average fixed asset growth for SMEs in each percentile of relative cash within the 90 percent interquartile range. In panel A average fixed asset growth is tracked over the period 2007-2014 and in panel B over the period 2001-2007. Fixed asset growth is defined as the log difference between 2007 and 2007+ j (crisis period) and between 2001 and year 2001+ j (pre-crisis period). Relative cash is calculated by subtracting from the firm's cash holdings its industry mean and divide the difference by the industry standard deviation and is measured in 2006 for the crisis period and in 2000 for the pre-crisis period. Industry mean and standard deviation are determined at the 4-digit level.

Figure 2: Autocorrelation cash holdings



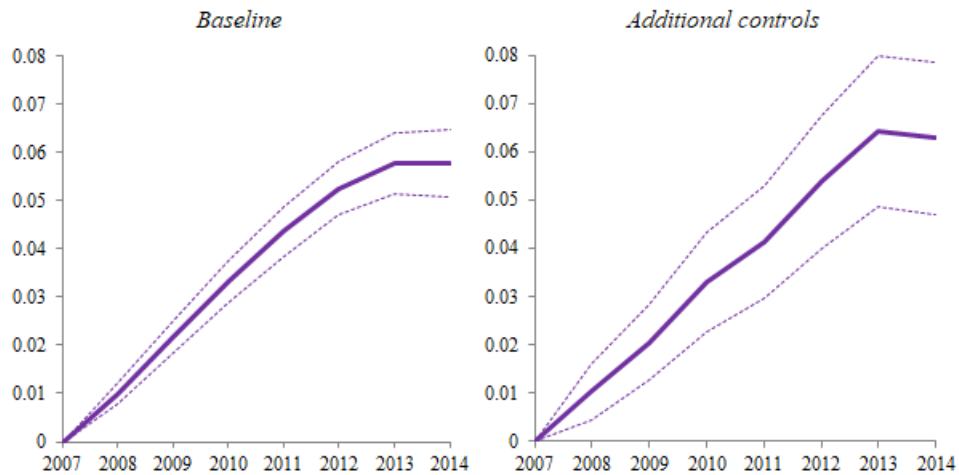
Notes: This figure plots the distribution of the one-lag auto-correlation coefficient of cash holdings over the period 2000 to 2006 of firms that are active during the period 2000-2014. Cash holdings are defined as deposits over total assets. The shaded area marks SMEs with volatile cash holdings.

Figure 3: Variations in cash holdings by industry



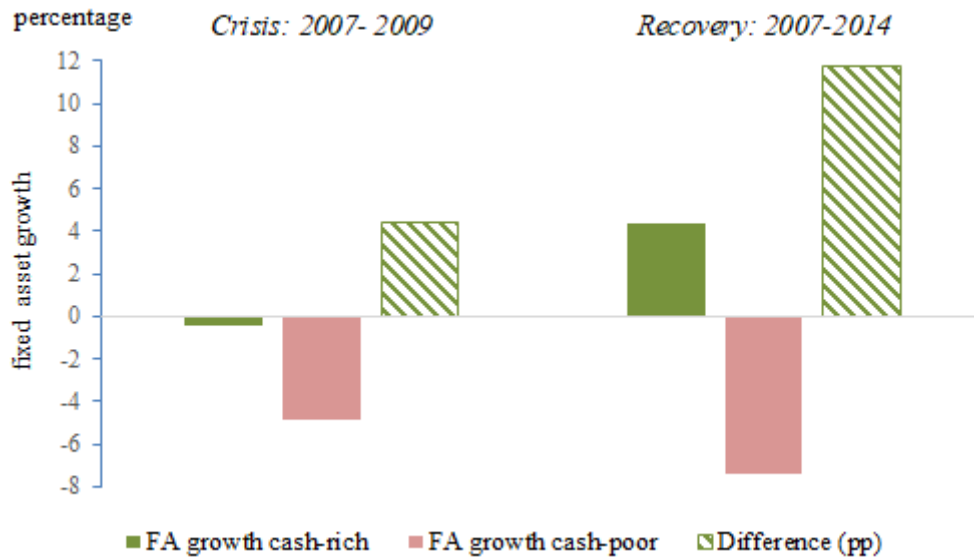
Notes: This figure plots the correlation between the mean and standard deviation of cash holdings of UK firms at the 4-digit industry level. The dotted lines depict the mean of each measure across industries. Cash holdings are defined as deposits over total assets and measured in 2006.

Figure 4: Long-term impact of cash on investment



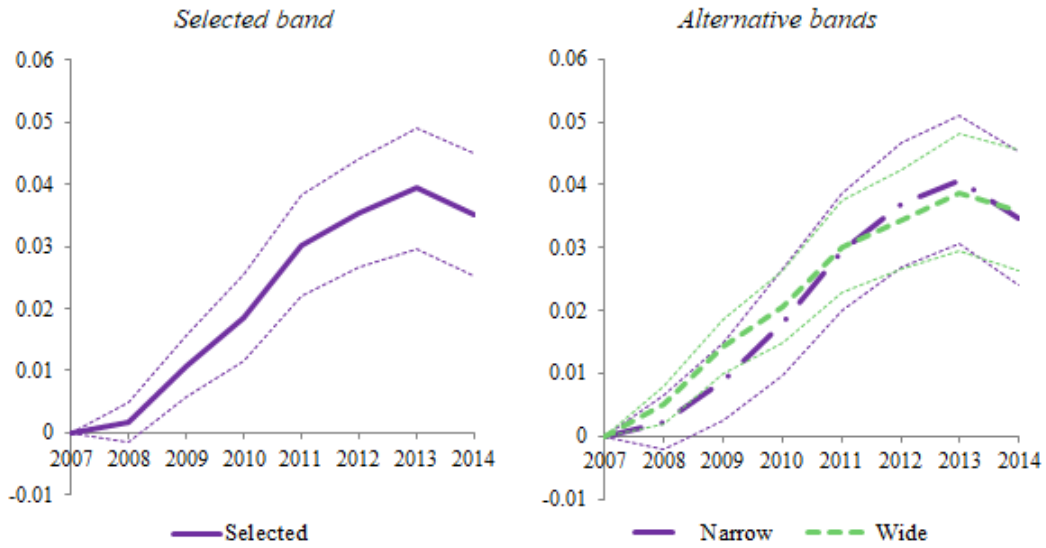
Notes: These figures plot the impact of relative cash on investment over different horizons using local projections. The dependent variable is the cumulative fixed asset growth between 2007 and $2007+j$, where j ranges from 1 to 7. The model specification used in the left-hand side panel includes controls for leverage, size, age category, group, profit and investment. The model specification used in the right-hand side panel also includes controls for turnover growth. All variables are measured in 2006, except investment and turnover growth which are measured over 2005-2006 and 2006-2007. Both specifications include region and 4-digit industry fixed effects. Standard errors allow for correlation at the 4-digit industry level. The lines correspond to the estimated parameter of *Relative cash* and the dashed lines show the 90 percent confidence intervals.

Figure 5: Estimated investment of cash-rich and cash-poor SMEs during crisis and recovery



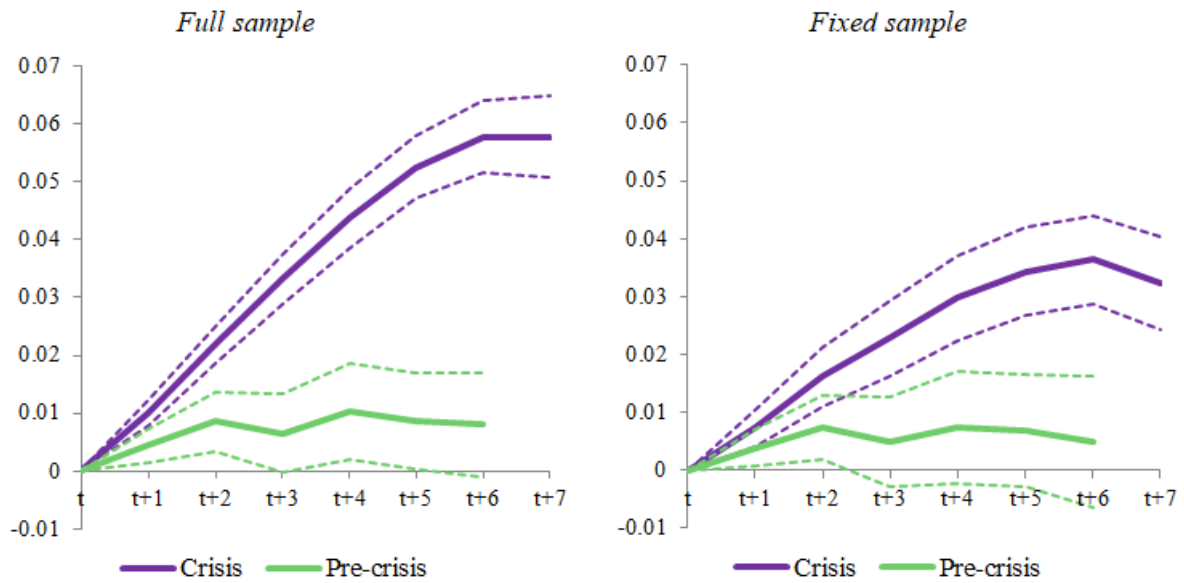
Notes: This figure plots the estimated cumulative fixed asset growth of cash-rich and cash-poor SMEs and the difference between the two based on the estimated coefficients of the baseline model. The left-hand side panel shows fixed asset growth between 2007 and 2009, the right hand side panel between 2007 and 2014. Cash-rich corresponds to the 90th percentile of the *Relative cash* distribution. Cash-poor corresponds to the 10th percentile.

Figure 6: Long-term impact of cash on investment - SMEs with volatile cash holdings



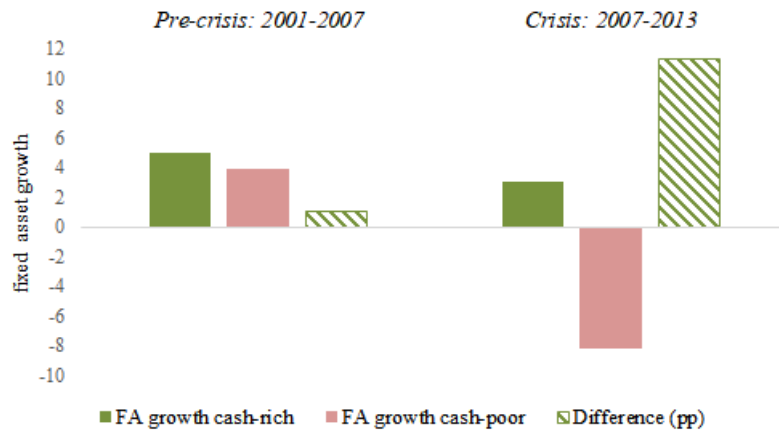
Notes: This figure plots the impact of relative cash on investment over different horizons using local projections for subsets of firms with volatile cash holdings. Cash volatility is measured as the one-lag auto-correlation coefficient of cash to total assets over the period 2000 to 2006. The left-hand side panel includes firms with a cash auto-correlation between -0.3 and 0.3, the right-hand side panel includes firms with a cash auto-correlation between -0.2 and 0.2 (narrow) or between -0.4 and 0.4 (wide). The dependent variable is the cumulative fixed asset growth between 2007 and $2007+j$, where j ranges from 1 to 7. All regressions include the standard control variables and region and 4-digit industry fixed effects. Standard errors allow for correlation at the 4-digit industry level. The line corresponds to the estimated parameter of *Relative cash* and the dashed lines show the 90 percent confidence intervals.

Figure 7: Long-term impact of cash on investment - crisis vs pre-crisis period



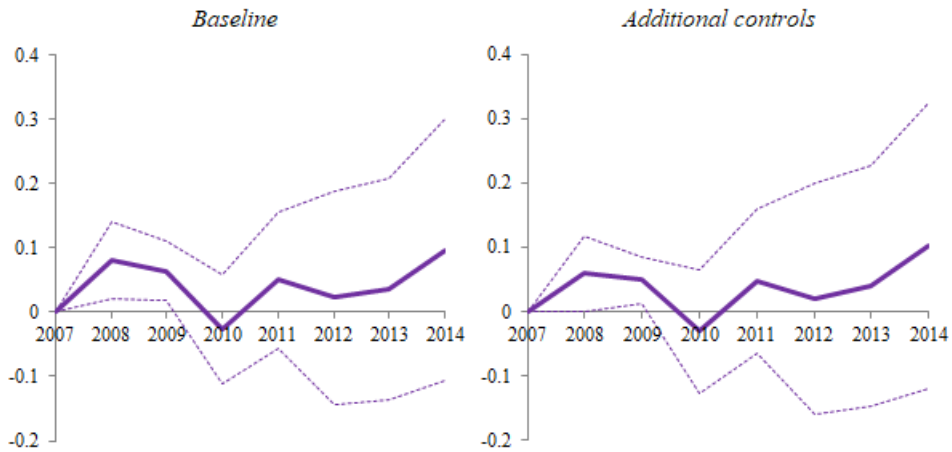
Notes: These figures plot the impact of relative cash on investment over different horizons using local projections for the crisis and pre-crisis periods. The dependent variable is the cumulative fixed asset growth between 2007 and 2007+j, where j ranges from 1 to 7 for the crisis sample and between 2001 and 2001+j, where j ranges from 1 to 6 for the pre-crisis sample. The full sample includes all firms for which information is available. The fixed sample includes the subset of firms that are both present in the crisis and the pre-crisis sample. All regressions include the standard control variables and region and 4-digit industry fixed effects. Standard errors allow for correlation at the 4-digit industry level. The lines correspond to the estimated parameter of *Relative cash* for the two periods and the dashed lines show the 90 percent confidence intervals.

Figure 8: Estimated long-term investment of cash-rich and cash-poor SMEs - crisis vs pre-crisis period



Notes: This figure plots the estimated cumulative fixed asset growth of cash-rich and cash-poor SMEs and the difference between the two based on the estimated coefficients of the baseline models for the pre-crisis and the crisis periods. The left-hand side panel shows fixed asset growth between 2001 and 2007 (pre-crisis) and the right-hand side panel between 2007 and 2013 (crisis). Cash-rich corresponds to the 90th percentile of the *Relative cash* distribution. Cash-poor corresponds to the 10th percentile.

Figure 9: Long-term impact cash on investment - publicly listed firms



Notes: These figures plot the impact of relative cash on investment over different horizons using local projections for the sample of publicly listed firms. The dependent variable is the cumulative fixed asset growth between 2007 and 2007+ j , where j ranges from 1 to 7. The model specification used in the left-hand side panel includes controls for leverage, size, age category, group, profit and investment. The model specification used in the right-hand side panel also includes controls for turnover growth. All variables are measured in 2006, except investment and turnover growth which are measured over 2005-2006 and 2006-2007. Both specifications include region and 4-digit industry fixed effects. Standard errors allow for correlation at the 4-digit industry level. The lines correspond to the estimated parameter of *Relative cash* and the dashed lines show the 90 percent confidence intervals.

Figure 10: Long-term impact of cash on survival



Notes: These figures plot the impact of relative cash on firm survival over different horizons using local projections. The dependent variable is a dummy that takes a value of 1 if the firm is active in $2007+j$ and zero otherwise, where j ranges from 1 to 7. The model specification includes controls for leverage, size, age category, group, profit and investment (one and two periods lagged). All variables are measured in 2006, except investment which is measured over 2005-2006 and 2006-2007. The left-hand side panel includes all SMEs, the right-hand side panel only SMEs with volatile cash holdings. All regressions include region and 4-digit industry fixed effects. Standard errors allow for correlation at the 4-digit industry level. The lines correspond to the estimated parameter of *Relative cash* and the dashed lines show the 90 percent confidence intervals.

Table 1: **Summary Statistics**

Variable Name	All SMEs - Crisis sample				SMEs with volatile cash holdings			
	Obs	Mean	Median	Std Dev	Obs	Mean	Median	Std Dev
$\Delta \ln FA$ (2007-2014)	204,412	-0.09	-0.07	1.03	60,977	-0.07	-0.05	0.80
Relative cash	204,412	-0.14	-0.39	0.84	60,977	-0.19	-0.44	0.80
Leverage	204,412	0.64	0.61	0.38	60,977	0.60	0.57	0.37
Size	204,412	5.39	5.38	1.56	60,977	5.71	5.77	1.55
Mature	204,412	0.19	0.00	0.39	60,977	0.27	0.00	0.45
Old	204,412	0.23	0.00	0.42	60,977	0.31	0.00	0.46
Group	204,412	0.08	0.00	0.27	60,977	0.11	0.00	0.31
Profit	204,412	0.30	0.33	0.39	60,977	0.33	0.36	0.39
Pre-Investment (1st lag)	204,412	0.03	-0.01	0.40	67,415	0.02	-0.01	0.39
Pre-Investment (2nd lag)	204,412	0.05	-0.01	0.41	67,415	0.04	-0.01	0.40
Pre-Turnover growth (1st lag)	27,428	0.06	0.06	0.40	8,851	0.04	0.05	0.39
Pre-Turnover growth (2nd lag)	27,428	0.09	0.06	0.43	8,851	0.06	0.06	0.39
Excess cash	185,667	0.01	-0.03	0.16	57,144	0.01	-0.04	0.15
Cash holdings	204,412	0.24	0.16	0.24	60,977	0.22	0.15	0.24
Relative cash (2007)	193,365	-0.14	-0.38	0.83	59,430	-0.18	-0.42	0.80
$\% \Delta Mshare$ (2007-2014)	195,562	0.14	-0.11	0.96	58,676	0.12	-0.10	0.90
$\% \Delta Local Mshare$ (2007-2014)	194,448	0.21	-0.12	1.25	58,676	0.19	-0.11	1.22
\sum Profit (2007-2014)	189,942	2.83	2.49	3.36	57,311	2.92	2.66	3.25
ROA (2007-2014)	188,609	0.31	0.33	0.38	56,935	0.33	0.36	0.37
$\Delta \ln Debt$ (2007-2014)	24,907	-0.61	0.00	1.79	7,278	-0.64	0.00	1.82
$\Delta \ln ST Debt$ (2007-2014)	24,907	-0.46	0.00	1.47	7,278	-0.47	0.00	1.49
$\Delta \ln LT Debt$ (2007-2014)	24,907	-0.38	0.00	1.55	7,278	-0.41	0.00	1.60
$\Delta Credit Score$ (2007-2014)	149,549	4.41	4.00	10.91	42,121	4.69	5.00	10.93
$\Delta \ln Cash$ (2007-2014)	178,608	0.20	0.21	1.27	53,614	0.19	0.21	1.29

Variable Name	All SMEs - Pre-crisis sample				Publicly listed firms			
	Obs	Mean	Median	Std Dev	Obs	Mean	Median	Std Dev
$\Delta \ln FA$ (2001-2007/2007-2014)	135,617	0.03	0.00	0.98	259	0.23	0.22	1.25
Relative cash	135,617	-0.14	-0.43	0.81	259	-0.20	-0.42	0.68
Leverage	135,617	0.65	0.63	0.37	259	0.45	0.53	0.31
Size	135,617	5.58	5.64	1.53	259	9.33	9.08	2.41
Mature	135,617	0.27	0.00	0.44	259	0.36	0.00	0.48
Old	135,617	0.30	0.00	0.46	259	0.31	0.00	0.46
Group	135,617	0.12	0.00	0.33	n.a.	n.a.	n.a.	n.a.
Profit	135,617	0.27	0.29	0.39	259	0.01	0.05	0.22
Pre-Investment (1st lag)	135,617	0.03	-0.01	0.40	259	0.17	0.06	0.49
Pre-Investment (2nd lag)	135,617	0.06	0.00	0.42	259	0.19	0.07	0.66

Notes: The table presents summary statistics for the key variables used in the empirical analyses for the full sample of SMEs (crisis and pre-crisis samples) for SMEs with volatile cash holdings and for the sample of publicly listed firms.

Table 2: **Pre-crisis characteristics cash-rich and cash-poor SMEs**

Variable	Cash-rich		Cash-poor		Normalized difference
	Mean	Variance	Mean	Variance	
Size (th)	543	989,478	966	2,088,079	-0.24
Young	0.47	0.25	0.38	0.24	0.13
Mature	0.25	0.19	0.31	0.21	-0.08
Old	0.27	0.20	0.31	0.21	-0.06
Group	0.05	0.05	0.13	0.11	-0.19
Leverage	0.48	0.10	0.72	0.15	-0.50
Profit	0.09	0.15	0.06	0.19	0.06
Investment	0.02	0.09	0.03	0.07	-0.02

Notes: This table presents means and variances of selected firm characteristics for SMEs with high and low cash holdings relative to their industry rivals for the subsample of SMEs with volatile cash holdings. Cash-rich firms are those in the top quartile of the relative cash distribution and cash-poor firms are in bottom quartile as measured in 2006. The last column reports the normalized difference, i.e. the difference between the average in the cash-rich and cash-poor groups divided by the square root of the sum of the variances. As a rule of thumb, Imbes and Wooldridge (2009) suggest that a normalized difference with an absolute value of 0.25 or less should not raise concerns about the variables being unbalanced. *Size* denotes the firms' total assets (in thousands). *Young* is a dummy which is one if the firm is 10 years or younger. *Mature* is dummy which is one if the firm is between 10 and 20 years old. *Old* is a dummy which is one if the firm is over 20 years old. *Group* is a dummy which is one if the firm is part of a group. *Leverage* denotes the share of total liabilities over total assets. *Profit* denotes the average profit growth between 2005 and 2006 and 2006 and 2007. *Investment* denotes the average of the log difference of the firm's fixed assets between 2005 and 2006 and between 2006 and 2007. All variables are measured in 2006 unless otherwise specified.

Table 3: **Cross-firm impact cash on investment, 2007-2014**

Financial constraints criteria	<i>All SMEs</i>			<i>SMEs with volatile cash holdings</i>		
	Constrained	Unconstrained	Difference (p-value)	Constrained	Unconstrained	Difference (p-value)
<i>Age</i>	<i>Young</i>	<i>Old</i>		<i>Young</i>	<i>Old</i>	
	0.073*** (0.005)	0.030*** (0.007)	0.00***	0.051*** (0.009)	0.013 (0.010)	0.00***
	119,408	46,228		25,254	18,910	
<i>Size</i>	<i>Small</i>	<i>Large</i>		<i>Small</i>	<i>Large</i>	
	0.100*** (0.009)	0.060*** (0.008)	0.00***	0.069*** (0.014)	0.048*** (0.011)	0.29
	51,174	51,071		11,313	19,641	

Notes: This table presents the estimates of relative cash on fixed asset growth from 2007-2014 across different groups of SMEs. Firms are classified on the basis of proxies for financial constraints based on their age and size. Constrained firms in terms of age are firms that are 10 years or younger and unconstrained firms are firms older than 20 years. Constrained firms in terms of size are firms in the bottom quartile of the total asset distribution and unconstrained firms are those in the top quartile. Age and size are measured in 2006. The regressions on the left-hand side are based on the full set of SMEs and the regressions on the right-hand side on the sample of SMEs with volatile cash holdings. All regressions include the control variables as specified in model (1) and include 4-digit industry and region fixed effects. Standard errors allow for correlation at the 4-digit industry level. The last column presents the p-value associated with the F-tests that compare the coefficients between the constrained and unconstrained subgroups, which is derived from a pooled regression in which we interact all variables with a dummy that is one if the firm is old or large, respectively. The number of firms in each group is in italics. Standard errors are in parentheses. *** indicates significance at the 1% level, ** at the 5% level, and * at the 10% level.

Table 4: Cross-industry impact cash on investment, 2007-2014

Industry criteria	<i>All SMEs</i>			<i>SMEs with volatile cash holdings</i>		
	Low	High	Difference (p-value)	Low	High	Difference (p-value)
<i>Panel A</i>						
Age	0.069*** (0.006) <i>91,604</i>	0.048*** (0.010) <i>20,524</i>	0.09* 	0.068*** (0.021) <i>24,700</i>	0.041*** (0.008) <i>7,180</i>	0.21
Size	0.072*** (0.006) <i>96,973</i>	0.038*** (0.014) <i>21,198</i>	0.02** 	0.039*** (0.007) <i>26,165</i>	0.041*** (0.014) <i>9,428</i>	0.90
<i>Panel B</i>						
Capital intensity	0.062*** (0.009) <i>51,353</i>	0.073*** (0.008) <i>34,203</i>	0.36 	0.044*** (0.013) <i>16,659</i>	0.068*** (0.014) <i>9,141</i>	0.20
Concentration	0.051*** (0.007) <i>85,587</i>	0.064*** (0.014) <i>29,985</i>	0.34 	0.025*** (0.008) <i>17,984</i>	0.049*** (0.018) <i>8,463</i>	0.25
Depth crisis	0.064*** (0.064) <i>61,592</i>	0.053*** (0.010) <i>18,750</i>	0.31 	0.041*** (0.014) <i>8,475</i>	0.031* (0.010) <i>5,787</i>	0.62

Notes: This table presents the estimates of relative cash on cumulative investment between 2007-2014 across different industries. The dependent variable is the log difference of fixed assets between 2007 and 2014. Industries are classified on the basis of different criteria. *Age* captures the industry mean firm age and *Size* the industry mean firm size. *Capital intensity* captures the industry mean firm ratio of fixed assets over total assets. *Concentration* equals the industry's Herfindahl index based on turnover. *Depth crisis* captures the mean firm growth in value added between 2007 and 2010. All measures are calculated at the 4-digit industry level. *Low* industries are those ranked in the bottom quartile of the respective distribution and *High* industries are those ranked in the top quartile of the same distribution, except for *Depth crisis* where *Low* captures the top quartile and *High* the bottom quartile. All industry characteristics, except depth crisis, are measured in 2006. The regressions on the left-hand side are based on the full set of SMEs and the regressions on the right-hand side on the sample of SMEs with volatile cash holdings. All regressions include the control variables as specified in model (1) and include 4-digit industry and region fixed effects. Standard errors allow for correlation at the 4-digit industry level. The last column presents the p-value associated with the F-tests that compare the coefficients between the high and low subgroups. The number of firms in each group is in italics. Standard errors are in parentheses. *** indicates significance at the 1% level, ** at the 5% level, and * at the 10% level.

Table 5: **Alternative cash measures**

Cash variable	Excess cash		Cash holdings		Relative cash (2007)	
	<i>Horizon</i> 2007-2009	2007-2014	2007-2009	2007-2014	2007-2009	2007-2014
<i>Panel A: All SMEs</i>						
	(1a)	(2a)	(3a)	(4a)	(5a)	(6a)
Cash variable	0.107*** (0.013)	0.355*** (0.029)	0.080*** (0.008)	0.215*** (0.017)	0.031*** (0.002)	0.071*** (0.004)
Firm controls	yes	yes	yes	yes	yes	yes
Industry fixed effects	yes	yes	yes	yes	yes	yes
Region fixed effects	yes	yes	yes	yes	yes	yes
<i>R-squared</i>	0.02	0.03	0.03	0.04	0.03	0.04
No. Observations	185,667	185,667	204,412	204,412	197,365	197,365
<i>Panel B: SMEs with volatile cash holdings</i>						
	(1b)	(2b)	(3b)	(4b)	(5b)	(6b)
Cash variable	0.025* (0.015)	0.183*** (0.035)	0.039** (0.011)	0.132*** (0.022)	0.025*** (0.003)	0.047*** (0.006)
Firm controls	yes	yes	yes	yes	yes	yes
Industry fixed effects	yes	yes	yes	yes	yes	yes
Region fixed effects	yes	yes	yes	yes	yes	yes
<i>R-squared</i>	0.02	0.03	0.02	0.03	0.02	0.03
No. Observations	57,143	57,143	60,976	60,976	59,430	59,430

Notes: This table presents the estimates of various cash measures on cumulative investment between 2007-2014 across different industries. The dependent variable is the log difference of fixed assets between 2007 and 2009 in the uneven columns and between 2007 and 2014 in the even columns. In columns 1 and 2 excess cash is used which is defined as the residual cash to total assets in 2006. In columns 3 and 4 cash holdings are used, which is defined as cash holdings over total assets in 2006. In columns 5 and 6 relative cash is measured in 2007 instead of 2006. The regressions in Panel A are based on the full set of SMEs and the regressions in Panel B on the sample of SMEs with volatile cash holdings. All regressions include the control variables as specified in model (1) and include 4-digit industry and region fixed effects. Standard errors allow for correlation at the 4-digit industry level. Standard errors are in parentheses. *** indicates significance at the 1% level, ** at the 5% level, and * at the 10% level.

Table 6: Competition channel

Sample	All SMEs				SMEs with volatile cash holdings			
Sectors	All		Non-tradables		All		Non-tradables	
<i>Horizon</i>	<i>2007-2009</i>	<i>2007-2014</i>	<i>2007-2009</i>	<i>2007-2014</i>	<i>2007-2009</i>	<i>2007-2014</i>	<i>2007-2009</i>	<i>2007-2014</i>
<i>Panel A: Market share</i>								
	(1a)	(2a)	(3a)	(4a)	(5a)	(6a)	(7a)	(8a)
Relative Cash	0.015*** (0.005)	0.019** (0.008)	0.002 (0.004)	0.033*** (0.012)	0.013*** (0.005)	0.022** (0.009)	0.008 (0.008)	0.043** (0.013)
Firm controls	yes	yes	yes	yes	yes	yes	yes	yes
Region FE	yes	yes	no	no	yes	yes	no	no
Area FE	no	no	yes	yes	no	no	yes	yes
<i>R-squared</i>	0.01	0.01	0.02	0.03	0.01	0.01	0.02	0.04
No. Obs.	195,562	195,562	25,836	25,836	58,676	58,676	6,877	6,877
<i>Panel B: Profit</i>								
	(1b)	(2b)	(3b)	(4b)	(5b)	(6b)	(7b)	(8b)
Relative Cash	0.041*** (0.003)	0.272*** (0.020)	0.023*** (0.004)	0.215*** (0.025)	0.036*** (0.004)	0.247*** (0.025)	0.024*** (0.008)	0.132*** (0.035)
Firm controls	yes	yes	yes	yes	yes	yes	yes	yes
Industry FE	yes	yes	yes	yes	yes	yes	yes	yes
Region FE	yes	yes	no	no	yes	yes	no	no
Area FE	no	no	yes	yes	no	no	yes	yes
<i>R-squared</i>	0.67	0.40	0.77	0.50	0.69	0.42	0.78	0.55
No. Obs.	189,942	189,942	24,849	24,849	57,310	57,310	6,656	6,656
<i>Panel C: ROA</i>								
	(1c)	(2c)	(3c)	(4c)	(5c)	(6c)	(7c)	(8c)
Relative Cash	0.019*** (0.001)	0.031*** (0.002)	0.015*** (0.002)	0.027*** (0.003)	0.019*** (0.001)	0.030*** (0.002)	0.014*** (0.004)	0.018*** (0.005)
Firm controls	yes	yes	yes	yes	yes	yes	yes	yes
Industry FE	yes	yes	yes	yes	yes	yes	yes	yes
Region FE	yes	yes	no	no	yes	yes	no	no
Area FE	no	no	yes	yes	no	no	yes	yes
<i>R-squared</i>	0.75	0.56	0.80	0.58	0.77	0.59	0.81	0.62
No. Obs.	192,006	192,006	24,832	24,832	57,633	57,633	6,619	6,619

Notes: This table presents the estimates of relative cash on market share growth (Panel A), cumulative profit (Panel B), and average ROA (Panel C). Growth rates are measured between 2007 and 2009 in the uneven columns and between 2007 and 2014 in the even columns. Columns 1 - 2 and 5 - 6 include all sectors and Columns 3 - 4 and 7 - 8 non-tradable sectors only. Market share growth in the former is relative to total assets in the firm's 4-digit industry, in the latter relative the total assets in the same industry and post-code area. The regressions on the left-hand side are based on the full set of SMEs and on the right-hand side on the sample of SMEs with volatile cash holdings. All regressions include all control variables as specified in model (2) plus the first and second lag of the respective dependent variables. Market share regressions include region/area fixed effects, all other regressions include region/area and 4-digit industry fixed effects. Standard errors allow for correlation at the 4-digit industry level. Standard errors are in parentheses. *** indicates significance at the 1% level, ** at the 5% level, and * at the 10% level.

Table 7: **Borrowing constraints channel**

Dependent variable	Total debt		Short-term debt		Long term debt		Credit score	
	<i>Horizon</i>	2007-2009	2007-2014	2007-2009	2007-2014	2007-2009	2007-2014	2007-2009
<i>Panel A: All SMEs</i>								
	(1a)	(2a)	(3a)	(4a)	(5a)	(6a)	(7a)	(8a)
Relative Cash	0.078*** (0.011)	0.140*** (0.016)	0.044*** (0.009)	0.112*** (0.013)	0.064*** (0.009)	0.115*** (0.016)	0.550*** (0.053)	0.872*** (0.057)
Firm controls	yes	yes	yes	yes	yes	yes	yes	yes
Industry FE	yes	yes	yes	yes	yes	yes	yes	yes
Region FE	yes	yes	yes	yes	yes	yes	yes	yes
<i>R-squared</i>	0.11	0.12	0.11	0.12	0.10	0.11	0.02	0.08
No. Obs.	20,906	20,906	20,906	20,906	20,906	20,906	144,197	144,197
<i>Panel B: SMEs with volatile cash holdings</i>								
	(1b)	(2b)	(3b)	(4b)	(5b)	(6b)	(7b)	(8b)
Relative Cash	0.097*** (0.022)	0.163*** (0.031)	0.071*** (0.018)	0.136*** (0.024)	0.060*** (0.018)	0.130*** (0.021)	0.381*** (0.074)	0.725*** (0.090)
Firm controls	yes	yes	yes	yes	yes	yes	yes	yes
Industry FE	yes	yes	yes	yes	yes	yes	yes	yes
Region FE	yes	yes	yes	yes	yes	yes	yes	yes
<i>R-squared</i>	0.14	0.14	0.14	0.13	0.14	0.16	0.02	0.13
No. Obs	7,242	7,242	7,242	7,242	7,242	7,242	41,666	41,666

Notes: This table presents the estimates of relative cash on debt and credit score growth. The dependent variable is cumulative growth in total debt (columns 1 and 2), in short-term debt (columns 3 and 4), in long-term debt (columns 5 and 6) and in credit scores (columns 7 and 8). Growth rates are measured between 2007 and 2009 in the uneven columns and between 2007 and 2014 in the even columns. The regressions in Panel A are based on the full set of SMEs and the regressions in Panel B on the sample of SMEs with volatile cash holdings. All regressions include all control variables as specified in model (2) plus the first and second lag of the respective dependent variables, except for the credit score regressions where the firm's credit score in 2006 is included. All regressions include region and 4-digit industry fixed effects. Standard errors allow for correlation at the 4-digit industry level. Standard errors are in parentheses. *** indicates significance at the 1% level, ** at the 5% level, and * at the 10% level.

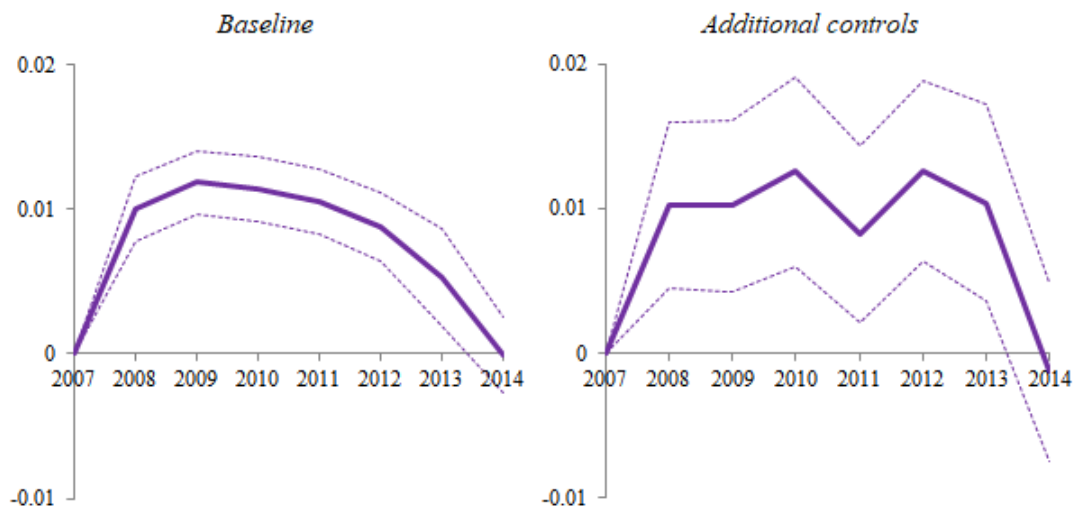
Table 8: **Precautionary savings channel**

Sample	All SMEs		SMEs with volatile cash		
	<i>Horizon</i>	<i>2007-2009</i>	<i>2007-2014</i>	<i>2007-2009</i>	<i>2007-2014</i>
	(1)	(2)	(3)	(4)	
Relative cash	-0.164*** (0.004)	-0.342*** (0.007)	-0.176*** (0.006)	-0.365*** (0.012)	
Firm controls	yes	yes	yes	yes	
Industry fixed effects	yes	yes	yes	yes	
Region fixed effects	yes	yes	yes	yes	
<i>R-squared</i>	0.11	0.13	0.12	0.13	
No. Observations	178,608	178,608	53,613	53,613	

Notes: This table presents the estimates of relative cash on growth in cash holdings. The dependent variable is cumulative growth in cash holdings between 2007 and 2009 in the uneven columns and between 2007 and 2014 in the even columns. Regressions in columns 1 and 2 are based on the full set of SMEs and in columns 3 and 4 on the sample of SMEs with volatile cash holdings. All regressions include all control variables as specified in model (2) plus the first and second lag of the dependent variable. All regressions include region and 4-digit industry fixed effects. Standard errors allow for correlation at the 4-digit industry level. Standard errors are in parentheses. *** indicates significance at the 1% level, ** at the 5% level, and * at the 10% level.

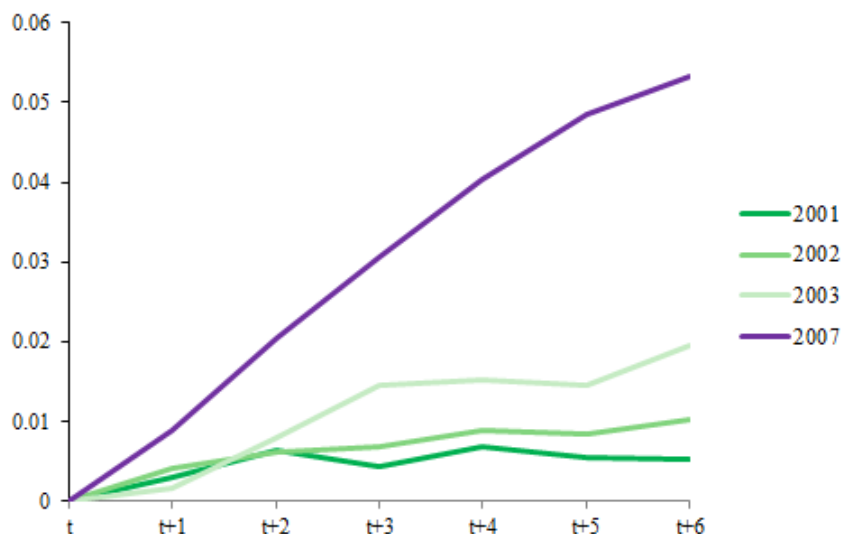
Appendix

Figure 1: Long-term impact of cash on annual investment rate



Notes: These figures plot the impact of relative cash on the annual investment rate over different horizons using local projections. The dependent variable is the annual fixed asset growth in year $2007+j$, where j ranges from 1 to 7. The model specification used in the left-hand side panel includes controls for leverage, size, age category, group, profit and investment. The model specification used in the right-hand side panel also includes controls for turnover growth. All variables are measured in 2006, except investment and turnover growth which are measured over 2005-2006 and 2006-2007. Both specifications include region and 4-digit industry fixed effects. Standard errors allow for correlation at the 4-digit industry level. The lines correspond to the estimated parameter of *Relative cash* and the dashed lines show the 90 percent confidence intervals.

Figure 2: Long-term impact of cash on investment - different tranquil periods



Notes: This figure compares the impact of relative cash on investment for different pre-crisis periods with the impact for the crisis period. It plots the impact of relative cash on investment over different horizons using local projections. The dependent variable is the cumulative fixed asset growth between year t and year $t+j$, where j ranges from 1 to 6 and where t equals 2001, 2002, 2003 or 2007. Relative cash is measured in year $t-1$ for all regressions. All regressions include the standard control variables as specified in model (1) and region and 4-digit industry fixed effects. Standard errors allow for correlation at the 4-digit industry level. The lines correspond to the estimated parameter of *Relative cash* for the four periods.

Table 1: **Variable definitions and sources**

Variable Name	Definition	Source
$\Delta \ln FA$	Log difference of fixed assets between 2007 and year 2007+ j (crisis period) or between 2001 and 2001 + j (pre-crisis period)	FAME
Relative cash	Cash holdings of the firm minus the (4-digit) industry mean cash holdings, divided by the (4-digit) industry standard deviation. Cash holdings equal deposits divided by total assets.	FAME
Leverage	Total liabilities over total assets	FAME
Size	Log of total assets	FAME
Mature	Dummy equal to one if the firm is between 10 and 20 years old	FAME
Old	Dummy equal to one if the firm is older than 20 years	FAME
Group	Dummy equal to one if the firm has a parent or is part of a group, which we define as a firm that reports an ultimate owner in FAME	FAME
ROA	Profit over total assets	FAME
Pre-Investment	Log difference of fixed assets between 2005 and 2006 and between 2006 and 2007 (crisis period) or between 1999 and 2000 and between 2000 and 2001 (pre-crisis period)	FAME
Pre-Turnover growth	Log difference of turnover between 2005 and 2006 and between 2006 and 2007 (crisis period) or between 1999 and 2000 and between 2000 and 2001 (pre-crisis period)	FAME
Industry age	Average age of firms in a 4-digit industry	FAME
Industry size	Average size of firms in a 4-digit industry	FAME
Industry capital intensity	Average fixed assets over total assets of firms in a 4-digit industry	FAME
Industry HHI	Herfindahl-Hirschman Index (HHI) based on turnover for each 4-digit industry	ONS
Industry depth crisis	Average growth of value added by firms in a 4-digit industry	ONS
Excess cash	Difference between a firm's actual and predicted cash holdings	FAME
$\% \Delta MShare$	Growth rate of the firm's market share over the period 2007 to 2009/2014, where market share is defined as the ratio of the firm's assets over the total 4-digit industry assets.	FAME
$\% \Delta Local MShare$	Growth rate of the firm's market share over the period 2007 to 2009/2014, where market share is defined as the ratio of the firm's assets over total assets of firms operating in the same post-code area and 4-digit (non-tradable) industry.	FAME
\sum Profit	Cumulative profits over the period 2007 to 2009/2014 scaled by total assets in 2007	FAME
ROA	Average ROA (profit/ta) over the period 2007 to 2009/2014	FAME
$\Delta \ln TotalDebt$	Log difference of total debt (short-term loans and overdrafts + trade credit + long-term debt) over the period 2007 to 2009/2014	FAME
$\Delta \ln STDebt$	Log difference of short-term debt (short-term loans and overdrafts + trade credit) over the period 2007 to 2009/2014	FAME
$\Delta \ln LTDebt$	Log difference of long-term debt over the period 2007 to 2009/2014	FAME
$\Delta CreditScore$	Log difference of credit score (QuiScore) over the period 2007 to 2009/2014	FAME
$\Delta \ln Cash$	Log difference of cash holdings over the period 2007 to 2009/2014	FAME