BANK OF ENGLAND

Staff Working Paper No. 843

All you need is cash: corporate cash holdings and investment after the financial crisis

Andreas Joseph, Christiane Kneer, Neeltje van Horen and Jumana Saleheen

January 2020

This is an updated version of the Staff Working Paper originally published on 20 December 2019

BANK OF ENGLAND

Staff Working Paper No. 843

All you need is cash: corporate cash holdings and investment after the financial crisis

Andreas Joseph,[1] Christiane Kneer,[2] Neeltje van Horen[3] and Jumana Saleheen[4]

Abstract

Firms with high pre-crisis cash holdings invested significantly more than their cash-poor rivals during the global financial crisis and especially so during the recovery phase. This resulted in a persistent and growing investment gap between cash-rich and cash-poor firms. Cash especially benefited young and small firms and firms in industries where rivals became more financially constrained. The amplification effect of cash was absent in the period preceding the crisis. The ability to continue to invest allowed cash-rich firms to gain market share and accumulate more profits over the long-run. Having a liquid balance sheet when the credit cycle turns thus gives firms a competitive edge that lasts far beyond the crisis years.

Key words: Firm investment, cash holdings, credit constraints, financial crisis.

JEL classification: E22, E32, E44, G32.

(1) Bank of England. Email: andreas.joseph@bankofengland.co.uk
(2) Bank of England. Email: christiane.kneer@bankofengland.co.uk
(3) Bank of England and CEPR. Email: neeltje.vanhoren@bankofengland.co.uk
(4) CRU Group. Email: jumana.saleheen@crugroup.com

The views expressed in this paper are those of the authors, and not necessarily those of the Bank of England or its committees. We are grateful to Andy Haldane, John Haltiwanger, Sebnem Kalemli-Ozcan, Kalina Manova, Steven Ongena, Ricardo Reis, Daniel Paravisini, Roberto Steri, Philip Strahan, Martin Strieborny and participants at the GSE Summer Forum – Financial Shocks, Channels and Macro Outcomes (Barcelona), 2nd Endless Summer Conference on Financial Intermediation and Corporate Finance (Athens), Belgium Macro Workshop (Ghent), Knut Wicksell Conference on Financial Intermediation (Lund), ESCoE Conference on Economic Measurement (London), and seminar participants at the Bank of England, Maastricht University, Lancaster University, Cass Business School, University of Lausanne, Warwick Business School and Glasgow University for useful comments and suggestions. Special thanks to Andrea Sisko for technical assistance.

The Bank's working paper series can be found at www.bankofengland.co.uk/working-paper/staff-working-papers

Bank of England, Threadneedle Street, London, EC2R 8AH
Email publications@bankofengland.co.uk

ISSN 1749-9135 (on-line)

1 Introduction

The year 2018 marked the 10th anniversary of the global financial crisis. In its wake, a large literature has emerged showing that financial crises have important consequences for the real economy in the short-run, with firms cutting investment and employment when credit conditions tighten.[1] But ten years on we still know very little about the long-term consequences of financial crises for firm performance. Do some firms permanently gain and others lose? Or are differences in firm performance just transitory and do losers catch up with winners during the recovery phase? This paper sheds some light on the long-term consequences of the global financial crisis on corporate investment and shows that cash is an important asset to have when the credit cycle turns. It enables firms to continue to invest when rivals cannot and this gives cash-rich firms a competitive edge that lasts far beyond the crisis years.

We start by documenting three stylized facts based on UK firm-level data covering both SMEs and large firms. First, firms' cash holdings show large variations not only *across* but also *within* narrowly defined industrial sectors (Figure 1).[2] This means that at any given point in time some firms in an industry will have large amounts of cash while others only very little. Second, contrary to commonly-held belief, for many firms cash holdings tend to fluctuate substantially year-on-year (Figure 2).[3] So while for some firms their cash position in a given year is the result of a deliberate cash management strategy, for others it is the outcome of variations in production/sale patterns and resulting (volatile) profit and cash flow. Third, the correlation between firms' cash holdings and their subsequent investment is very different in tranquil compared to crisis times. When we rank firms according to the size of their cash holdings relative to their industry rivals in the year 2000, only a weak relationship with investment over the period 2001-2007 emerges: both cash-rich and cash-poor firms increased their fixed assets over this period (Figure 3, top panel). When we rank firms based on their relative cash holdings in 2006 instead, we see that a firm's cash position strongly correlates with its investment over the period 2007-2014.[4] While firms with cash continued to invest throughout the crisis, cash-poor firms were shrinking their fixed assets instead. And this divergence in investment behaviour became even more pronounced during the recovery period

[1] See Bernanke (2018) for an extensive review of the literature.

[2] It is well-established in the literature that cash holdings differ importantly across industries. Cash holdings are for example more valuable in industries with volatile cash flows (Kim, Mauer, and Sherman, 1998; Opler, Pinkowitz, Stulz, and Williamson, 1999; Han and Qiu, 2007) and in industries where the correlation between cash flows and investment opportunities is low (Acharya, Almeida, and Campello, 2007).

[3] On average the 1-lag autocorrelation of a firm's cash holdings relative to its industry rivals is only 0.22 and even weaker for young and small firms. The distribution of the 1-lag autocorrelation of absolute cash holdings is very similar with the average autocorrelation equal to 0.20.

[4] The variation in cash holdings within industry is very similar in 2000 compared to 2006. As such the differential pattern cannot be explained by sharp differences in cash holdings in the two periods.

(Figure 3, bottom panel). This suggests that having cash at hand when credit conditions tighten can give firms a considerable advantage, not only in the short-term but especially in the long-term.

There are several reasons why cash holdings can have a positive impact on firm investment during a crisis. First, cash provides a firm with an internal source of funds when credit conditions tighten, external finance becomes more costly and cash flows decline.[5] A firm can use these internal funds to cover its expenditures, pay off debt and finance profitable investment projects (Froot, Scharfstein, and Stein, 1993).[6] Second, when asset prices decline cash preserves its value and can serve as high-quality collateral that a firm can pledge to raise external funds (Lian and Ma, 2018). Third, a cash-rich firm does not have to increase its cash holdings for precautionary motives in the wake of a negative economic or funding shock and can use these funds for investment instead (Almeida, Campello, and Weisbach, 2004; Berg, 2018).

Firms with ample cash at hand can thus more easily continue to operate and seize profitable investment opportunities despite the tightening of credit conditions. Their cash-starved rivals by contrast have to forgo profitable investment opportunities, may be forced to liquidate fixed assets and may even struggle to survive (Campello, Giambona, Graham, and Harvey, 2011). Thus, while the stock of fixed assets of cash-poor firms may fall, cash-rich firms can increase theirs, allowing an investment gap between cash-rich and cash-poor firms to open up.

Because of these contrasting investment patterns, the productive capacity of cash-rich firms expands while that of cash-poor firms shrinks. This improves the competitive position of cash-rich firms. This will be especially the case when cash-rich firms can acquire assets at discounted prices from their struggling competitors or when their presence deters other firms from entering or investing (Benoit, 1984). They can further exploit the weakness of their cash-poor rivals by strategically investing in R&D, the location of stores and plants, distribution networks or advertising (Campello, 2006) or by lowering their prices (Gilchrist, Schoenle, Sim, and Zakrajšek, 2017).

During the recovery phase when demand returns and credit conditions improve, cash-rich firms have more capacity to meet this demand and can subsequently reinvest their earn-

[5]During the global financial crisis the cost of external finance increased sharply as banks reduced the supply of credit (Ivashina and Scharfstein, 2010; Santos, 2011).

[6]Standard valuation models treat cash like the negative of debt which implies that cash does not have an independent impact and only net leverage (debt minus cash) should matter. The key underlying assumption of these models is that financing is frictionless: a firm that uses cash to pay off its debt today is expected to be able to issue new debt tomorrow under the same conditions. This assumption has been challenged even for publicly listed firms and during non-crisis times (Acharya, Almeida, and Campello, 2007) and is even less likely to hold during crisis episodes.

ings, increasing their productive capacity further. Cash-poor rivals, due to their loss in productive capacity will have difficulties catching up and see their positions weaken further. This effect could be reinforced if banks with weakened balance sheets after the crisis only resumed lending to low-risk firms. The investment gap between cash-rich and cash-poor firms that opened up during the crisis is thus amplified during the recovery period.

The feedback-loop described above implies that a firm's pre-crisis cash position relative to its industry rivals is a strong predictor of long-term investment after a financial crisis. To test the validity of this prediction, we use a local projections framework (Jordà, 2005).[7] We trace out the impact of the global financial crisis on investment of firms with different pre-crisis levels of cash relative to their industry rivals over different horizons between 2007 and 2014. This allows us to test whether initial cash holdings affected investment during the crisis and assess whether the effect was amplified over longer time horizons when self-reinforcing dynamics set in. We control for a wide set of firms' pre-crisis characteristics, including leverage, performance and investment, that might be correlated with a firm's cash position and its ability to invest during the crisis and recovery period. To control for demand shocks and investment opportunities we use 4-digit industry fixed effects. The fixed effects absorb for each investment horizon the impact of industry conditions, including industry-specific uncertainty, demand and other factors affecting all firms in an industry in the same way.

We use a firm-level dataset with balance sheet information of private firms and publicly listed companies based in the UK. It is manually constructed from Moody's (previously Bureau van Dijk's) FAME database and covers the period 1999 to 2014. This dataset is ideally suited for our purpose for several reasons. First, it covers small and young firms and is not confined to large, publicly listed companies which are usually the focus of studies on corporate cash holdings and investment. This is important for any analysis on the effects of financial crises as small and young firms are critical to a dynamic economy but they are more likely affected by a tightening of financial constraints as they typically require more lender screening and monitoring (Almeida, Campello, and Weisbach, 2004; Iyer, Peydró, da Rocha-Lopes, and Schoar, 2014). Second, it covers both the period leading up to the crisis, the crisis itself and the recovery phase. This allows us to compare cash-investment sensitivities during the financial crisis and its aftermath with the sensitivities during the pre-crisis period. We can therefore test whether a tightening of credit conditions altered this sensitivity.

A potential concern with our identification strategy is that a firm's cash policy might be endogenously related to its investment opportunities during and after the crisis. We address this concern in several ways. First, we measure the firm's relative cash position in 2006,

[7] See Jordà, Schularick, and Taylor (2013), Favara and Imbs (2015), Mian, Sufi, and Verner (2017) and Wix (2017) for recent applications of local projections in finance.

i.e. prior to the onset of the financial crisis. As the global financial crisis was unexpected, it is unlikely that firms were hoarding cash in 2006 in anticipation of a credit supply shock that would affect their future ability to invest. Second, we control for a wide range of firm characteristics that might explain both a firm's cash holdings and (post-)crisis investment. Third, we exploit cross-sectional differences as they relate to a tightening of financial constraints during the crisis at both the firm- and industry-level. Finally, we make use of the fact that for many firms cash holdings tend to fluctuate substantially year-on-year. This implies that at least for a substantial part of the firm population the firm's relative cash position in 2006 is random and therefore plausibly exogenous to the firm's ability to perform well during a financial crisis. This is similar in spirit to exploiting exogenous variation in refinancing needs of firms due to the exact moment a (long-term) loan is maturing as prioneered by Almeida, Campello, Laranjeira, and Weisbenner (2012).[8]

In line with the evidence provided by Duchin, Ozbas, and Sensoy (2010) and Berg (2018), we find that firms with high initial levels of cash relative to industry rivals invested more during the financial crisis.[9] But this is not where the benefit of having cash ended. As suggested by the mechanism described above, the positive effect of cash not only persisted but was amplified during the recovery phase. Across all industries, a firm in the 90^{th} percentile of the relative cash distribution grew its stock of fixed assets between 2007 and 2009 by 4.4 percentage points more than a firm in the 10^{th} percentile. Extending the horizon to 2014, this difference almost tripled to 11.6 percentage points. Thus, the initial investment gap between cash-rich and cash-poor firms that opened during the crisis widened significantly during the recovery phase. This cash effect was present for firms that were persistently cash-rich and for firms whose cash holdings fluctuated significantly in the period leading up to the crisis. In other words, having high levels of cash when the credit cycle turns, whether due to sheer luck or because of carefully managed cash buffers, positively affected firms' long-term investment patterns after the crisis.

If it were generally the case that cash-rich firms invest more in the long term than

[8] Another concern can be the presence of unobserved credit lines. As shown by Ivashina and Scharfstein (2010) firms were drawing down their credit lines during the global financial crisis. This can positively affect their ability to invest during the crisis and the subsequent recovery period. However, as shown by Campello, Giambona, Graham, and Harvey (2011), during the crisis firms that had enough internal funds available choose not to use their credit lines. This suggests that credit lines are more expensive than having cash at hand especially for firms that become financially constrained. Indeed, Sufi (2009) finds that access to credit lines becomes more restricted following declines in borrower profitability. Acharya, Almeida, Ippolito, and Perez (2014) provide a theoretical rationale for this behaviour by showing that credit lines can serve a liquidity monitoring role. This makes the cost of credit lines greater for firms with high liquidity risk. Furthermore, banks tend to increase interest rates and make loan provisions less borrower-friendly when firms, faced with a cash flow shock, draw on or increase their credit lines (Brown, Gustafson, and Ivanov, 2017).

[9] Different from us, these papers differentiate between firms according to their absolute levels of cash, not their cash holdings relative to their rivals.

their cash-poor rivals, we should find a similar trajectory for the cash coefficient during the period that preceded the crisis. Instead, we find that the amplification effect was unique to the post-crisis recovery period and was not present in the tranquil period that preceded the global financial crisis. This suggests that the tightening of credit conditions played an important role in driving the effect we document.

Cross-sectional analyses exploiting firm and industry heterogeneity lends additional support to our hypothesis. We show that the impact of relative cash is particularly large for young and small firms which are more likely to become financially constrained during a crisis. In addition, cash-investment sensitivities are larger for firms operating in industries where the average firm is younger or smaller. In other words, and as expected, the benefits of having cash were especially pronounced in industries where firms more likely became financially constrained during the downturn. Other industry characteristics such as capital intensity, competition or depth of crisis do not seem to play a role.

The underlying mechanism of the feedback loop we describe is the ability of cash-rich firms to increase their productive capacity which allows them to capture market share from their cash-poor rivals. In line with this competition channel, we find that firms with high initial levels of cash captured market share from their cash-poor industry rivals during the crisis and this effect was amplified during the recovery phase. Again, we do not find that cash helped firms increase their market share during the pre-crisis period.[10] The positive impact of cash holdings on market share growth during the crisis and the recovery period was again largest for young and small firms and in industries where firms more likely became financially constrained. Besides increasing their market shares, cash-rich firms were also able to accumulate more profits over the period 2007-2014 compared to their cash-poor rivals.

Our findings support the idea that the tightening of credit constraints during a financial crises allows cash-rich firms to gain a strategic advantage over their cash-poor and hence more financially constrained rivals. The ability to continue to invest during a crisis gives cash-rich firms a competitive edge that does not only benefit them during the crisis but even more so in the subsequent recovery period. Our findings highlight the importance of having a liquid balance sheet when the credit cycle turns for a firm's long-term growth after a financial crisis.

The remainder of the paper is structured as follows. The next section discusses how this paper contributes to the literature. Section 3 introduces the empirical strategy and the data. Section 4 reports the results on the long-run effects of cash on firm investment and Section 5 presents evidence on the impact of cash on market share growth and firm operating performance. Section 6 concludes.

[10] Fresard (2010) finds for publicly listed companies in the US that firms with higher cash holdings do increase their market share in the short-run during tranquil times. However, he studies market shares in terms of sales and his sample only includes publicly listed firms.

2 Contribution to the literature

This paper lies at the intersection of the literature on the real effects of credit constraints and on corporate liquidity management. In the wake of the global financial crisis a large literature has emerged studying its consequences. Banks, faced with a deterioration of their balance sheet, increased the cost and reduced the supply of credit (Ivashina and Scharfstein, 2010; Santos, 2011). Firms dependent on credit from these banks responded to the tightening of credit conditions by cutting down on investment, employment and output (e.g. Campello, Graham, and Harvey, 2010). Young and small firms reacted especially strong (e.g. Chodorow-Reich, 2014; Ongena, Peydro, and Van Horen, 2015; Cingano, Manaresi, and Sette, 2016) as they were not able to compensate for the credit crunch by switching to other sources of external funding (Iyer, Peydró, da Rocha-Lopes, and Schoar, 2014). The health of the bank's balance sheet critically determined the magnitude of its credit contraction (Puri, Rocholl, and Steffen, 2011), but the firm's balance sheet played an important role as well. Firms that had to roll over a significant amount of debt during the crisis (e.g. Almeida, Campello, Laranjeira, and Weisbenner, 2012; Wix, 2017; Duval, Hong, and Timmer, 2019) or that faced bigger debt overhang problems (Kalemli-Ozcan, Laeven, and Moreno, 2018) were much more affected by the crisis than others.[11] On the other hand, firms with ample cash on their balance sheet where much less affected and continued to invest during the crisis (Duchin, Ozbas, and Sensoy, 2010).

While the short-term effects of the financial crisis are fairly well understood, we still know very little about its long-run consequences. A notable exception is the work of Wix (2017) who shows that large firms that were faced with maturing debt when the crisis hit reduced investment in the short-run, with no catch-up effect in the long-run. We instead focus on the asset side of a firm's balance sheet and study investment behavior of not only large, established firms but also young firms and SMEs. We confirm that a liquid balance sheet can insulate a firm from the credit supply shock in the short-run. But this is not where the benefit of being cash-rich ends. Having cash at hand puts a firm, especially a young or small one, on an entirely different investment path that persists long after credit conditions have loosened again. Our findings thus highlight that focusing exclusively on the direct crisis episode severely underestimates the impact of a financial crisis on firm performance.

The importance of corporate liquidity management to lessen financial constraints has received ample attention in the literature. Already Keynes (1936) highlighted the advantage of a liquid balance sheet for undertaking valuable investment projects when they arise, particularly in the presence of financial constraints. In line with this, prior literature shows that

[11] Focusing on the Great Depression, Benmelech, Frydman, and Papanikolaou (2019) show that financial frictions as a result of maturing corporate bonds had a strong negative causal effect on firm employment.

financially constrained firms hold more cash for precautionary motives (e.g. Opler, Pinkowitz, Stulz, and Williamson, 1999; Faulkender and Wang, 2006; Acharya, Almeida, and Campello, 2007) and that cash reserves allow financially constrained firms to invest more especially when their hedging needs are large (Denis and Sibilkov, 2010).[12] Firms tend to increase their cash holdings after a negative macroeconomic or funding shock (Almeida, Campello, and Weisbach, 2004; Song and Lee, 2012), which leads them to reduce investment (Berg, 2018) and employment (Bancchetta, Benhima, and Poilly, 2019). Others provide evidence of the protective effect of a liquid balance sheet on firm investment in the face of a contractionary monetary policy shock (Ottonello and Winberry, 2018; Jeenas, 2018) or a credit supply shock (Beck, Da-Rocha-Lopes, and Silva, 2018). We add to this literature by showing that cash not only protects firms from the impact of a credit supply shock, but that it enables them to gain a competitive edge that lasts well into the recovery phase. In line with Fresard (2010) we show that one mechanism behind the growing investment gap between cash-rich and cash-poor firms that we document is the ability of cash-rich firms to capture market share from their cash-poor rivals.

3 Empirical methodology and data

Our paper aims to test whether a firm's pre-crisis cash position relative to its industry rivals is a strong predictor of long-term investment after a financial crisis and whether changes in competition dynamics drive this. In this section, we explain the empirical methodology for our investment regressions and discuss the data and variables used for this analysis. The methodology and variables that we use to analyze the competition mechanism are discussed in Section 5.

3.1 Empirical methodology

We use a local projections framework (Jorda, 2005) to study how a firm's cash position going into the crisis affects its investment decisions 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

[12]The 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).

[13]Local 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 (Jorda, 2005).

conditional on the firm's cash position relative to its rivals in 2006, i.e. two years before the crisis. 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:

$$\Delta lnFA_{i,07+j} = \beta_j Relative\ cash_{i,06} + \gamma_j X_i + \sum_{k=0}^{1} \theta_{kj} \Delta lnFA_{i,07-k} + \rho_{sj} + \vartheta_{rj} + \varepsilon_{ij}, \quad (1)$$

where subscript 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. $\Delta lnFA_{i,07+j}$ 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 as a share of its total assets and is measured relative to the cash holdings of the firm's rivals within 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 may directly correlate with its cash position. In particular, we include two age dummies, *Mature* and *Old*, the dummy variable *Group* which indicates whether a firm is part of a corporate group or not, and the dummy variable *Public* which indicates whether the firm is publicly listed or not. We also include three continuous variables: *Size* which is defined as the log of total assets, *Leverage* which is defined as total liabilities over total assets and *Profits* which equals profits over total assets. All these control variables are measured in 2006. To control for the fact that investment decisions can be lumpy the model also includes 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. ρ_{sj} is a vector of 4-digit industry fixed effects, ϑ_{rj} is a vector of regional fixed effects, and ε_{ij} is the error term at horizon j. More detailed definitions of all variables are provided in the next section.

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, 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.

The main coefficients of interest in regression (1) are the β_j coefficients. Our estimates for β_j measure the sensitivity of firms' investment decisions 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 relative to their rivals grow more over horizon j. Because of the dynamic nature of the coefficients, we will present the estimation results as graphs and plot the estimates of β_j over horizons $j = 1,\ldots 7$.

3.2 Firm balance sheet data

Our primary data source is the FAME database provided by Moody's (previously by Bureau van Dijk). The FAME database is a subset of the more commonly used Amadeus (European firms) and Orbis (global firms) datasets that Moody's provides. 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 each firm at Companies House, the official UK firm registrar, and therefore capture most of the UK's corporate universe.[14] The dataset is different from datasets that are commonly used in the literature on the real effects of financial crises and corporate investment decisions such as Compustat or Worldscope. These datasets only contain information on large and publicly listed companies. The vast majority of companies in FAME by contrast are small and medium sized firms (SMEs) which are privately owned. The FAME dataset therefore allows us to study the post-crisis investment behavior of both SMEs and young firms, i.e. the kind of firms that are more likely to be affected by a tightening of financial conditions during the crisis.

A critical part of our identification strategy relies on comparing firms' cash-investment sensitivities during the crisis and its aftermath with their sensitivities during the pre-crisis period. This comparison allows us to demonstrate that the usual relationship between cash holdings and long-term investment changed when credit constraints tightened during the crisis. To perform this comparison, we require a dataset that covers not only the global financial crisis and its recovery, but also the tranquil period before the crisis. The key complicating factor is that FAME is a live database and historical information of inactive or dissolved companies is only retained up to five years after firm exit. We would therefore introduce survival bias in the earlier years of our analysis if we relied exclusively on a recent FAME download of the firm data.

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.[15] Each vintage contains ten years of financial accounts for active companies and

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

[15] As discussed in great detail by Kalemli-Ozcan, Sorensen, Villegas-Sanchez, Volosovych, and Yesiltas (2015) and implemented for the UK by Bahaj, Foulis, and Pinter (2019), the use of historical information and careful treatment of the data is crucial to construct an accurate firm-level panel using data provided by Moody's.

five years for inactive or dissolved companies.[16] The accounts of a firm in each vintage are uniquely identified by the firm's Companies House registration number and the account filing date. When overlaying different vintages of accounts, we retain non-missing balance sheet information from those firm's accounts that were most recently filed. Thus, 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. This exercise significantly reduces survival bias and substantially improves data coverage.

All firms are by law required to report to Companies House, but 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 a subset of large firms.[17] Furthermore, UK firms 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. 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.[18]

Firms are classified by 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 or are dominated by the public sector.[19] 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 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.

3.3 Regression variables

Our dependent variable is the growth in fixed assets. 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 invest-

[16] We use the following vintages: March 2007, April 2012 and May 2017.

[17] See Bahaj, Foulis, and Pinter (2019) for a detailed description of firm reporting requirements in the UK.

[18] The vast majority of accounts cover a 12-month period. Occasionally, we also observe irregular filings or multiple filings in a single year by firms. 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.

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

ment is zero. We focus on net investment as measured by the log difference in fixed assets since net investment matters most for the productive capacity of the firm.

Our key variable of interest is the level of corporate cash holdings prior to the global financial crisis, as measured by bank deposits over total assets. We are primarily interested in the cash that a firm holds relative to its rivals in the same industry. This is because the competitive advantage that a firm potentially gains by holding cash buffers will depend on the cash holdings of its competitors. Furthermore, as is well established in the literature, the importance of cash holdings for mitigating financial constraints depends critically on industry characteristics. Cash holdings are for example more valuable in industries with volatile cash flows (Kim, Mauer, and Sherman, 1998; Opler, Pinkowitz, Stulz, and Williamson, 1999; Han and Qiu, 2007) and in industries where the correlation between cash flows and investment opportunities is low (Acharya, Almeida, and Campello, 2007).

To construct a measure of relative-to-rivals cash holdings, we follow MacKay and Phillips (2005) and Fresard (2010) and standardize the ratio of cash to total assets within each industry at the 4-digit level. Specifically, we compute *Relative cash* by subtracting from the firm's cash holdings its industry mean and divide the difference by the industry standard deviation in 2006. Measuring cash this way accounts for the fact that a 5 percent cash deviation in an industry with a standard deviation of 3 percent provides more value than it does in an industry with a standard deviation of 10 percent.

We include a number of firm-specific variables to control for the main determinants of investment. Small firms and young firms 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-to-rivals cash holdings. We define the variable *Size* as the log of total assets in 2006. We measure the age of each firm as the number of years between the firm's incorporation date and 2006. Based on this variable 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 is between 10 and 19 years and *Old* which is one if the firm is 20 years or older (young firms are therefore in the omitted category).

A number of studies show that the level of debt had a negative effect on investment during the crisis period (see, among others, Duval, Hong, and Timmer, 2019; Kalemli-Ozcan, Laeven, and Moreno, 2018). As leverage might also be correlated with cash holdings, we control for *Leverage* measured as the firm's total liabilities over total assets in 2006. Firms that have generated profits in the run up to the crisis also likely have higher cash holdings and might be better equipped to perform well during the crisis. To control for this we include *Profit* as measured by the firm's profits over total assets in 2006.

Some of the firms in our sample are part of a group structure and have access to

liquidity through their corporate group. Access to an internal capital market can mitigate financial constraints of affiliated firms (see Boutin, Cestone, Fumagalli, Pica, and Serrano-Velarde, 2013). We include a dummy variable *Group* which is one if the firm has a parent and reports an ultimate owner in FAME. Firms that do not report an ultimate owner or whose ultimate owning company name is the same as the firm name are considered as stand-alone entities.[20] Finally, we include the dummy variable *Public* to account for the fact that publicly listed firms have access to additional sources of external finance.

Investment tends to be lumpy and is often partially 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. To control for this we include a variable that captures annual investment of the firm in the pre-crisis period, *Pre-Investment*, and that equals the log difference of fixed assets between 2005 and 2006 and between 2006 and 2007.

For the subset of firms for which we have more detailed balance sheet information we include an additional control variable capturing the firm's pre-crisis performance which could be correlated with both cash holdings and future investment opportunities. We control for *Pre-Turnover* which is defined as the log difference in turnover measured over the same period 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.

Our analysis focuses on firms with complete data on relative-to-rivals cash, the control variables and investment over all horizons. This ensures that we follow the same set of firms over time and that our coefficients are not affected by firm entry or exit. The sample for our baseline investment analysis thus consists of 235,396 firms and the sample for our extended analysis which also controls for pre-crisis turnover consists of 34,519 firms. Descriptive statistics for these firms are shown in Table 1.

3.4 Characteristics of cash-rich and cash-poor firms

Figure 1 shows that cash holdings vary substantially *across* industries. Industry averages of cash holdings range from seven to around 50 percent of total assets, with a mean across all industries of 20 percent. This wide variation in average cash holdings reflects the fact that hedging needs and the volatility of cash flows differ across industries. Importantly, cash holdings also vary substantially *within* industries. On average, the standard deviation of firms' cash holdings as a share of total assets is 20 percent. This is the variation we will exploit throughout the paper.

Table 2 sheds light on the characteristics of firms with high or low cash holdings relative

[20] We thank Bahaj, Foulis, and Pinter (2019) for sharing this information with us.

to industry rivals. Cash-rich firms are defined as those in the upper quartile of the relative-to-rivals cash distribution in 2006 and cash-poor firms are those in the lower quartile. Cash-rich firms hold on average 57 percent of their balance sheet in liquid form, while cash-poor firms only hold 3 percent of total assets in cash. Comparing other pre-crisis characteristics of the two types of firms, we find that cash-rich firms tend to be small, somewhat younger, have less fixed assets, are less leveraged and are more profitable. We do not observe a difference in pre-crisis investment between cash-rich and cash-poor firms.

4 Long run effects of relative-to-rivals cash on investment

In this section, we use local projections to examine whether a firm's pre-crisis cash position relative to its industry rivals affects long-term investment after a financial crisis.

4.1 Results: Post-crisis investment and relative-to-rivals cash

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 consistent with a credit supply shock mitigated by the availability of liquid assets and is in line with the findings of Duchin, Ozbas, and Sensoy (2010) and Berg (2018).

Interestingly, the coefficient continues to be positive beyond the initial crisis years and even increases over the recovery period. The positive impact of high relative-to-rivals cash is not only persistent but is amplified over time. This suggests that firms with relatively high levels of cash prior to the crisis continued to invest more compared to their low-cash rivals even when the crisis subsided, credit became more readily available and demand returned. Quantitatively, the estimates imply that across all industries, the stock of fixed assets of a firm in the 90^{th} percentile of the relative cash distribution grew by 4.4 percentage points more between 2007 and 2009 than that of a firm in the 10^{th} percentile. For fixed asset growth between 2007 and 2014, this difference almost tripled to 11.6 percentage points.

While our model controls for investment opportunities at the industry level by including granular industry fixed effects, it does not control for investment opportunities at the firm level. This could bias our results if cash holdings are correlated with the firms' investment opportunities in the years ahead. Firms might decide to hold more cash precisely because they

expect their investment opportunities to be greater in the long run. This is usually addressed by including Tobin's q as a control variable. Since Tobin's q is only available for publicly listed firms, we instead extend the model by controlling for the pre-crisis performance of the firm as captured by its turnover growth in the two years prior to the crisis. Firms that perform well may have higher earnings that they can hold as cash. At the same time, high-performing firms might have better investment opportunities in the future. If this is the case, then the positive relationship between cash and long-term investment might not be driven by a tightening of credit conditions but by firm performance. As only larger firms report turnover in the UK, we estimate this extended model for a much smaller sample of large firms. The coefficients in Figure 4 (right hand panel) show a pattern similar to the baseline regressions including the strong amplification effect over longer horizons.[21]

As argued in the introduction, the persistence of relative cash is rather low for most firms (on average the autocorrelation over the period 2000-2006 is only 0.22). But there exists a lot of heterogeneity across firms with some firms being persistently cash-rich or cash-poor while others see their relative cash holdings fluctuate substantially over time. This indicates that for some firms their cash position in 2006 is the result of a long-term strategy to maintain a liquid or illiquid balance sheet. For other firms, it is more the outcome of year-on-year variation in production and sale patterns and resulting (volatile) profit and cash flow. This reduces concerns that *Relative cash* proxies for some time-invariant firm characteristic such as prudent management which could be correlated with a firm's ability to invest during a financial crisis and is at least for the subset of firms with cyclical cash holdings plausibly exogenous to the firm's ability to perform well during a financial crisis.

We exploit this randomness in cash holdings just prior to the crisis to assuage concerns that our results are driven by the subset of firms with more persistent relative-to-rivals cash holdings. This is similar in spirit to Almeida, Campello, Laranjeira, and Weisbenner (2012) and Wix (2017) who exploit randomness in the moment long-term debt is maturing to identify the impact of firms' leverage on investment and firm growth during the global financial crisis. To this end we split our sample into firms with weak, intermediate and strong autocorrelation (Figure 5). When we compare the estimates of the cash-investment sensitivity we find that the cash coefficient is positive and significant for all three groups and the effect is amplified over time.[22] In other words, having high levels of cash when the credit cycle turns, whether due

[21] We 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.

[22] As we are only able to compute the autocorrelation for the subset of firms which have information on their cash-holdings for each year between 2000 and 2006, these regressions are based on a smaller subset of 115,494 firms. As this sample is biased towards older firms for which (as we will show in the next section) the

to sheer luck or because of carefully managed cash buffers, positively affects firms' long-term investment patterns after the crisis.

4.2 Results: Investment during the pre-crisis period and relative-to-rivals cash

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"). To this end we estimate a similar model for the pre-crisis period. If it were generally the case that cash-rich firms invest more in the long-term than their cash-poor rivals, we should find a similar trajectory of the cash-investment sensitivity parameter for this period.

We measure a firm's cash position in 2000 and trace out the cash-investment sensitivity parameter for the period 2001-2007.[23, 24] The control variables are the same as in the baseline crisis model 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. As before, we focus on the set of firms with complete data on relative-to-rivals cash, the control variables and investment for all horizons. This leaves us with a sample of 158,175 firms.

The results shown in Figure 6 are striking. Contrary to our estimates for the 2007-2014 period, the β_j -coefficients for the pre-crisis period are only significant for the first two years (at the 10 percent level) and become insignificant thereafter. Not only are the coefficients for the pre-crisis sample much smaller than (and statistically different from) the coefficients for the crisis sample, 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. If the sample of firms we observe in the pre-crisis period contains a larger share of firms with a naturally low cash to long-term investment sensitivity this might explain the difference between the two periods. To ensure that this is not driving our results and that firms in the two samples are comparable we match a firm from our crisis sample with a firm from the pre-crisis sample along some key characteristics and re-estimate the model for the two periods based on this smaller set of matched firms. We require the two firms to match exactly in terms of their 4-digit industry, region, age and size group and the quartiles of leverage, profits and investment, where for the crisis sample all variables are

cash-investment sensitivity is weaker, the coefficients for the different subsets of firms are lower compared to the coefficients for the full sample of firms as used in Figure 4.

[23] We choose a horizon of six rather than seven years to ensure that our pre-crisis analysis does not overlap with the crisis period.

[24] The distribution of cash holdings at the 4-digit industry level is very similar in 2000 and in 2006, with an industry mean of 17 percent and a standard deviation of 19 percent.

measured in 2006 and for the pre-crisis sample in 2000. This leaves us with a matched sample of 72,366 firms for each period. The estimates for β_j using the matched samples are shown in the right-hand side panel of Figure 6. The results are very similar to those for the unmatched samples, except that the coefficients for the first two periods in the pre-crisis sample are now also statistically insignificant.

Given that our database starts in 1999, we choose 2001 as the beginning of our pre-crisis period to maximize the horizon over which we can estimate β_j before the start of the financial crisis. This coincides with the aftermath of the dot-com crash in 2000 which could affect our results even though the effect on the UK economy was relatively weak compared to the US. To ensure that our findings using 2001 as the starting year are representative of pre-crisis trends more generally, we test whether results change when we begin our analysis for the pre-crisis period in 2002 or 2003 instead. Reassuringly, when we use 2002 or 2003 as starting years (and accordingly measure relative cash in 2001 or 2002) we find that the results are similar to those obtained for our pre-crisis sample starting in 2001 (Appendix Figure 1).

These results show that the impact of cash on investment was very different in the pre-crisis period compared to the crisis period and its recovery. This suggests that the tightening of credit conditions played an important role in driving the effect we document.

4.3 Results: Cross-sectional analysis

To provide additional support to the hypothesis that a tightening of credit conditions makes cash more valuable for firms, we next perform a number of cross-sectional analyses exploiting firm and industry heterogeneity as they relate to a tightening of financial constraints during the crisis.

4.3.1 Firm-level

First, we conduct a cross-sectional analysis based on firm-level measures of access to external finance. If liquid assets were beneficial because credit conditions deteriorated during the crisis, this effect should be particularly strong for firms that were more affected by a reduction of banks' credit supply. We use two proxies for financial constraints that are commonly used in the literature to test whether cash-investment sensitivities varied with firms' exposure to credit supply shocks: the age and size of the firm. Small and young firms typically require more lender screening and monitoring and are therefore more likely to be affected by a tightening of financial constraints (Almeida, Campello, and Weisbach, 2004; Iyer, Peydró, da Rocha-Lopes, and Schoar, 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 regression 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. For brevity, we only display the cash coefficients. The p-value associated with the F-test that compares the coefficients between the two groups is derived from the pooled regression in which we interact all variables with a dummy that is one if the firm is old. The results show that when comparing young and old firms, the coefficient is significantly larger for young firms. Quantitatively, a young firm in the 90^{th} percentile of the relative cash distribution grows its stock of fixed assets by 14.6 percentage points more than a young firm in the 10^{th} percentile by 2014. For old firms this difference is only 7.2 percentage points.

Next we examine the difference between small and large firms, where small firms are those in the lowest quartile of the size distribution and large firms those in the highest quartile of the size distribution. The results (Table 3, lower panel) show that, as expected, the cash–investment sensitivity over the horizon 2007-2014 is also larger for small firms, but the difference between large and small firms is just statistically insignificant (p-value 0.14). Quantitatively, a small firm in the 90^{th} percentile of the relative cash distribution grows its stock of fixed assets by 18.7 percentage points more than a large firm in the 10^{th} percentile by 2014. For large firms this difference is only 12.9 percentage points.

These findings are consistent with the idea that a tightening of credit conditions made cash more valuable and enabled firms with cash to continue to invest while their cash-poor rivals needed to divest.

4.3.2 Industry-level

To further uncover the drivers behind our findings, we now exploit the diversity in industries that is present in our dataset. This not only helps us to put aside any possible remaining endogeneity concerns, but also furthers our understanding of the circumstances under which cash is particularly valuable for firms when a financial crisis hits.

First, to strengthen the causal interpretation of our findings we identify sectors in which firms likely became more financially constrained during the crisis. If cash holdings provide a firm with a strategic advantage, the impact of relative-to-rivals cash should be larger in industries where the firm's rivals face more difficulties obtaining external funds during the crisis. As argued previously, firms that are small and 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 (i.e. the firm's rivals) tend to be small or young.

To test this prediction, we follow Fresard (2010) and measure financial constraints

affecting the firm's rivals as the mean size and the mean age of firms within the 4-digit industry in 2006.[25] We then rank the industries based on each of the two variables and assign firms in the bottom and top industry quartiles to the "low" and "high" category, respectively. For each industry characteristic we then estimate equation (1) separately for the "low" and the "high" subsamples 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 fully 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 the mean firm is small or young. The cash coefficient is also significant in industries where rivals are older and larger, but the cash effect is much smaller. Cash coefficients for firms operating in the top and bottom quartile industries are significantly different from each other at the one percent level, irrespective of our measure of financial constraints.

Beyond the financial constraints that rivals' face, other industry characteristics might also impact the effectiveness of cash in boosting firms' investment. We investigate these in panel B of Table 4. First, we examine whether it matters whether the industry is more labor or more capital intensive. We capture this by taking the mean fixed asset to total asset ratio of firms within the 4-digit industry in 2006 and again compare industries in the top and bottom quartile of the industry distribution. The results indicate that the cash-investment sensitivity is similar for industries that are labor intensive and those that are capital intensive.

The fierceness of the competition a firm faces in an industry could determine how effective cash is in boosting its investment. 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 boosts firms' investment in industries with both high and low concentration. The coefficient is larger for firms operating in concentrated markets, but the difference is not statistically significant.[26] In both concentrated and competitive industries, cash holdings present an important competitive advantage during a crisis and its recovery phase.[27]

[25] Results are very similar if we use the median age and size.

[26] Results are very similar when we use a measure of HHI based on employees.

[27] Note 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.

Finally, we examine if the extent to which an industry suffered from the crisis affected the cash-investment sensitivity. 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 shrinking rivals could arise in industries that were hit hard by the crisis. Furthermore, lenders more likely 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 be 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 value added between 2007 and 2010. The data are again from the ONS. Comparing firms in industries in the bottom quartile of the industry growth distribution with those in the top quartile, we find that cash holdings allowed firms to invest more in industries that weathered the crisis relatively well as well as in industries which suffered a severe downturn during the crisis.

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, while other industry characteristics played less of a defining role.

4.4 Results: Tangible vs intangible fixed assets

Up till now we focused on investment in total fixed assets, without differentiating between its subcomponents. Fixed assets consist of on the one hand tangible fixed assets such as property, plant and equipment and on the other hand intangible fixed assets such as copyrights, trademarks, patents, licenses and brand value. In this section we disentangle these two subcomponents in order to shed light on which type of investment is driving our findings.

Only a small subset of large firms (16,616) report tangible and intangible fixed assets. For these firms we trace out the cash-investment sensitivity coefficient separately for total, tangible and intangible fixed asset growth. The results are provided in Figure 7. The estimates clearly show that relative cash only affects investment in tangible fixed assets. Cash does not seem to impact investment in intangible fixed assets.

A number of factors can explain this difference. First, the magnitude of the cash coefficient captures both the ability of cash-rich firms to continue to invest and the need of cash-poor firms to reduce their fixed asset (Figure 3b). It is easier for a cash-starved firm to reduce its stock of tangible fixed assets, for example by not renewing its car park, compared to reducing its intangible fixed assets. In addition, the weaker results on intangible assets could also be related to the greater difficulty of measuring them. As they are non-physical assets

they are harder to value and simple depreciation rates cannot be applied. Third, accounting standards mandate that a business cannot recognize any internally-generated intangible assets (with some exceptions), only acquired intangible assets. This means that intangible assets listed on a balance sheet were most likely gained through the acquisition of another business, or were purchased outright as individual assets. As such any investment in internally-generated intangible assets will not be captured by the data.

5 Relative-to-rivals cash, market share growth and operating performance

In the previous section, we documented the emergence of an investment gap between cash-rich and cash-poor firms during the crisis which was amplified during the recovery period. In this section, we explore whether competition dynamics were a possible driver behind the widening investment gap and examine how cash affects firms' market share growth and operating performance.

5.1 Competition dynamics

When credit conditions tighten, firms that are starved of cash might be forced to liquidate fixed assets and forgo profitable investment opportunities (Campello, Graham, and Harvey, 2010). Their cash-rich rivals by contrast can draw on internal resources to continue to operate and seize profitable investment opportunities. As the capacity of cash-poor firms to meet demand declines, cash-rich firms can capture market share from these shrinking or failing firms (Froot, Scharfstein, and Stein, 1993). Cash-rich firms may even be able to acquire assets at discounted prices from their struggling competitors, improving their position further. Thus, even if demand contracts during a crisis, the market for cash-rich firms may actually expand.

In addition, cash-rich firms can invest in competitive strategies that allow them to further increase their market share at the expense of cash-poor rivals. Having cash reserves allows firms to invest strategically in R&D, the location of stores and plants, distribution networks or advertising (Campello, 2006) which improves their future competitive position. Furthermore, the presence of firms with large amounts of cash can deter rivals from entering a market or from expanding their capacity (Benoit, 1984). Cash reserves may also allow firms to strategically lower their prices to steal market share from financially weak competitors that have to maintain or increase their prices in order to generate cash flow (Gilchrist, Schoenle, Sim, and Zakrajšek, 2017).

While having cash may also be beneficial during normal times, its value likely in-

creases when cash flow is low, credit conditions tighten and external finance becomes more costly. Fresard (2010), studying publicly listed US firms, shows that in normal times cash-rich firms systematically increase their market share in the short-run at the expense of their cash-poor rivals. He finds that this effect is larger when a firm's rivals face tighter financing constraints, suggesting that the short-term relationship between cash and competition that Fresard documents might be stronger during a crisis.

Feedback effects could reinforce the shifts in firms' competitive positions during crisis periods and amplify the effect of initial cash holdings on market share growth in the recovery phase. Firms that were able to invest and capture market share during a crisis are in a better position to meet demand when it returns. This improves their earnings and strengthens their balance sheets, allowing them to capture even more market share and to keep investing. Firms that are cash-poor at the onset of a crisis may therefore not be able to catch up with their cash-rich rivals and continue to see their positions weaken even when credit conditions improve.

This section assesses whether there is evidence in favour of the mechanism outlined above. We test how pre-crisis cash holdings affected a firm's market share growth during the financial crisis and the recovery phase. This will allow us to assess whether the amplification of the investment gap over time could have been driven by the ability of cash-rich firms to gain market share which subsequently put them on a higher growth trajectory relative to their cash-poor rivals.

5.2 Regression specification

Similar to our investment regressions, we test how a firm's market share growth over the horizon $j > 0$ was affected by the financial crisis conditional on the firm's cash position relative to its rivals just before the crisis. We regress firm i's market share growth between 2007 and year 2007+j, $\%\Delta MShare_{i,07+j}$, on the firm's cash position and a number of control variables. Market share is defined as the ratio of the firm's assets over the total assets in its 4-digit industry.[28] Market share growth therefore measures a firm's asset growth relative to its competitors. We estimate the following regression model:

[28]Ideally, a firm's market share is measured in terms of its sales. However, in the UK this variable is only available for a subset of large and old firms. Since particularly small and young firms benefit from having large cash holdings as the results in Section 4.4.1 indicate, limiting the sample to large and old firms for which this variable is available would lead to a downward bias. We therefore decided to measure a firm's market share in terms of its total assets.

$$\%\Delta MShare_{i,07+j} = \beta_j Relative\ cash_{i,06} + \gamma_j X_i + \sum_{k=0}^{1} \theta_{kj} \%\Delta MShare_{i,07-k} + \vartheta_{rj} + \varepsilon_{ij} \quad (2)$$

where subscript i indexes the firm and j the horizon over which market share growth is measured, with j ranging from one to seven years. *Relative cash* is defined as the cash holdings of the firm relative to the cash holdings of its rivals as measured in 2006. The control variables are the same as in specification (1) and include the firm's size, age, leverage and whether it is part of a group or publicly listed. In addition, we control for pre-crisis market share growth (one and two periods lagged) in order to capture firm characteristics that may have driven the firm's competitive position in the past. ϑ_{rj} is a vector of regional fixed effects and ε_{ij} is the error term at horizon j. As the dependent variable is a relative-to-industry variable all industry-specific factors are already removed from the estimates and there is no need to include industry fixed effects. Regressions are again estimated for each horizon separately using OLS and standard errors are clustered at the 4-digit industry level. As before, we focus on the set of firms with complete data on relative-to-rivals cash, the control variables and market share growth for all horizons. This leaves us with a sample of 225,613 firms.

To assess to what extent the tightening of financial constraints during the financial crisis affected the importance of cash holdings for subsequent firm performance, we compare the cash - market share growth sensitivity during the crisis and its aftermath with the sensitivity in the pre-crisis period. We therefore estimate the same model also for the pre-crisis period where relative-to-rivals cash is measured in 2000 and model (2) is estimated for each horizon between 2001 and 2001 + j, with j ranging from one to six. If the strategic value of cash increases when financial constraints tighten, then the cash-market share growth sensitivity should be larger during the crisis period.

5.3 Results: Market share growth and relative-to-rivals cash

Figure 8 presents the β_j estimates for each horizon. The panel on the left shows the estimates for both the crisis and the pre-crisis period for the full sample of firms and the panel on the right shows the coefficients for the matched sample. The results indicate that firms with high levels of cash relative to their rivals prior to the crisis experienced higher market share growth during the crisis and the subsequent recovery period. In line with the mechanism outlined above, the coefficient follows an upwards trajectory in both the full and the matched samples. By contrast, we do not find a significant effect of relative-to-rivals cash on market

share growth in the pre-crisis period.[29] Taking the estimates from the full sample, a firm in the 90th percentile of the relative cash distribution increases its market share after 7 years by 3.7 percentage points more than a firm in the 10th percentile after a financial crisis.

If cash holdings enable firms to gain a competitive advantage over their rivals this effect should be stronger for firms that are more likely financially constrained. As before, since information asymmetries between borrowers and lenders tend to be more pronounced for young and small firms, we use firms' age and size as a proxy for the financial constraints that they face. We examine whether the effect of cash on market share growth over the longest horizon from 2007 to 2014 differs for the subsamples of young and old firms, and for the subsamples of small and large firms. We find (Table 5) that young and small firms that are cash-rich gain market share relative to their young or small cash-poor rivals. Quantitatively, a young firm in the 90th percentile of the relative cash distribution grows its market share by 6.7 percentage points more than a young firm in the 10th percentile by 2014. For small firms this number equals 12.2 percentage points. We do not find a significant effect of cash on market share growth for old or large firms.

When we again differentiate across industry characteristics, we find results that are very similar to those we found when examining fixed asset growth (Table 6). The impact of cash on market share growth is only significant in industries where firms more likely face a tightening of credit conditions during the crisis, i.e. when firms tend to be small or young. When we split industries across our measures of capital intensity, concentration and depth of crisis we do not find that the cash effect is statistically different in the two types of industries.

These findings support the hypothesis that the value of cash holdings increases during a financial crisis because financial conditions tighten. Cash reserves provide a clear strategic advantage when the credit cycle unexpectedly turns, not only during the crisis episode itself but also several years thereafter.

5.4 Results: Cash and firm operating performance

As a final test, we examine how the competitive effect of cash affected firm value. To this end, we examine how measures of operating performance are related to relative cash.[30] As measures of operating performance we use the firm's cumulative profits and ROA (as defined by EBITDA over total assets) over the period 2007-2009 and over the period 2007-2014. In addition, we examine the growth in the number of employees over the two time periods (defined

[29] Fresard (2010) instead finds that firms with higher cash holdings do increase their market share in the short-run during tranquil times. However, he studies market shares in terms of sales and his sample only includes publicly listed firms.

[30] As most of our firms are SMEs that are privately owned, we cannot study the impact on firms' market-to-book ratios as a measure of market value.

by the log difference). Except for firm's profits, these variables are only available for a (very) small subset of large firms who report more detailed balance sheet information.

We estimate a model similar to regression model (1) and control for the firm's size, age, leverage and whether it is part of a group or publicly listed. A firm with a lot of growth opportunities may hold more cash compared to its rivals. To reduce concerns that this is affecting our results we include pre-crisis values of the respective performance variables (one and two periods lagged) in order to capture firm characteristics that may have driven the firm's performance in the past. We again include 4-digit industry and region fixed effects. Regressions are estimated for the two horizons separately using OLS and standard errors are clustered at the 4-digit industry level. We focus exclusively on the set of firms with complete data on relative-to-rivals cash, the control variables and the respective dependent variable for both horizons.

The results in Table 7 indicate that having cash at hand when the credit cycle turns also enhances firm operating performance. Cash-rich firms accumulate more profits during the crisis and this effect is amplified during the recovery period. This finding is confirmed when we examine ROA (the p-value of the cash coefficient for the period 2007-2014 is 0.18), even though this measure is only available for 2,000 firms. The only measure that does not seem to be affected by a firm's cash position going into the crisis is employee growth. While the cash coefficient is positive and significant at the 10 percent level during the crisis, this effect disappears during the recovery period. As we only observe employment for a subset of large firms this may explain why we do not find an effect. Overall, these findings are consistent with the idea that having access to a liquid balance sheet when the credit cycle turns contributes positively to a firm's operating performance.

6 Conclusions

This paper identifies an important link between a firm's pre-crisis cash holdings and its long-term investment and competitive position after the global financial crisis. Firms with high initial levels of cash relative to their industry rivals invested more during the financial crisis. During the recovery phase the positive impact of relative cash not only persisted but was amplified. This persistent and widening investment gap between cash-rich and cash-poor firms was not present in the pre-crisis period. We posit that an underlying driver behind the amplification of the investment gap is the ability of cash-rich firms to persistently outcompete their cash-poor rivals. In line with this mechanism, we find that cash holdings before the onset of the crisis had a positive effect on market share growth during the crisis and this effect was again amplified during the recovery phase. In addition we show that cash contributed

positively to a firm's operating performance.

We argue that the feedback mechanism we document is the consequence of a tightening of credit constraints during a financial crisis. Firms with internal sources of funds can continue to invest during the crisis and capture market share at the expense of financially constrained rivals. When the recovery sets in, credit conditions improve and demand returns, these initially cash-rich firms are much better placed to meet this demand. They can subsequently reinvest their earnings, improving their positions further. Consistent with a causal effect of a shock to firms' ability to raise external financing during crisis episodes, we find that the long-term effect of cash on investment and market share growth was larger for young and small firms which likely suffered more from deteriorating credit conditions. We also show that cash-rich firms invested more and managed to increase their market share more in industries where their rivals more likely became credit constrained.

Our findings thus show that having access to liquid assets when the credit cycle turns is an important determinant of firms' long-term growth. This suggests that it is not only important for policy makers to monitor the indebtedness of firms in the economy but also the levels of liquid assets they have available. As cash is not the same as negative debt, especially not when financial conditions tighten, monitoring net debt (i.e. debt minus cash) as opposed to debt and cash holdings separately might hide vulnerabilities that are building up. Furthermore, direct interventions during the crisis that can avoid firms faced with liquidity problems having to liquidate their fixed assets could help. Policies that incentivise banks to continue lending to firms during a crisis, such as funding-for-lending schemes, might be useful as long as banks do not redirect the new funding they receive only to those firms that already have ample liquid assets to begin with.

References

Acharya, V., H. Almeida, and M. Campello (2007): "Is cash negative debt? A hedging perspective on corporate financial policies", *Journal of Financial Intermediation*, 16, 515–554.

Acharya, V., H. Almeida, F. Ippolito, and A. Perez (2014): "Credit lines as monitored liquidity insurance: Theory and evidence", *Journal of Financial Economics*, 112, 287–319.

Almeida, H., M. Campello, B. Laranjeira, and S. Weisbenner (2012): "Corporate debt maturity and the real effects of the 2007 credit crisis", *Critical Finance Review*, 1, 3–58.

Almeida, H., M. Campello, and M. S. Weisbach (2004): "The cash flow sensitivity of cash", *The Journal of Finance*, 59, 1777–1804.

Bahaj, S. A., A. Foulis, and G. Pinter (2019): "Home values and firm behaviour", *American Economic Review*, (fothcoming).

Bancchetta, P., K. Benhima, and C. Poilly (2019): "Corporate cash and employment", *American Economic Journal: Macroeconomics*, 11, 30–66.

Beck, T., S. Da-Rocha-Lopes, and A. F. Silva (2018): "Sharing the pain? Credit supply and real effects of bank bail-ins", CEPR Discussion Paper No. 12058.

Benmelech, E., C. Frydman, and D. Papanikolaou (2019): "Financial frictions and employment during the great depression", *Journal of Financial Economics*, 133, 541–563.

Benoit, J.-P. (1984): "Financially constrained entry in a game with incomplete information", *The RAND Journal of Economics*, 15, 490–499.

Berg, T. (2018): "Got rejected? Real effects of not getting a loan", *The Review of Financial Studies*, 31, 4912–4957.

Bernanke, B. (2018): "The real effects of the financial crisis", *Brookings Papers on Economic Activity*, BPEA Conference Drafts, September 13-14.

Boutin, X., G. Cestone, C. Fumagalli, G. Pica, and N. Serrano-Velarde (2013): "The deep-pocket effect of internal capital markets", *Journal of Financial Economics*, 109, 122–145.

Brown, J., M. Gustafson, and I. Ivanov (2017): "Weathering cash flow shocks", Mimeo Iowa State University, Penn State University and Federal Reserve Board.

Campello, M. (2006): "Debt financing: Does it boost or hurt firm performance in product markets?", *Journal of Financial Economics*, 82, 135–172.

Campello, M., E. Giambona, J. R. Graham, and C. R. Harvey (2011): "Liquidity management and corporate investment during a financial crisis", *The Review of Financial Studies*, 24, 1944–1979.

Campello, M., J. R. Graham, and C. R. Harvey (2010): "The real effects of financial constraints: Evidence from a financial crisis", *Journal of financial Economics*, 97, 470–487.

Chodorow-Reich, G. (2014): "The employment effects of credit market disruptions: Firm-level evidence from the 2008–9 financial crisis", *The Quarterly Journal of Economics*, 129, 1–59.

Cingano, F., F. Manaresi, and E. Sette (2016): "Does credit crunch investment down? New evidence on the real effects of the bank-lending channel", *The Review of Financial Studies*, 29, 2737–2773.

Denis, D. J. and V. Sibilkov (2010): "Financial constraints, investment, and the value of cash holdings", *The Review of Financial Studies*, 23, 247–269.

Dittmar, A. and J. Mahrt-Smith (2007): "Corporate governance and the value of cash holdings", *Journal of Financial Economics*, 83, 599–634.

Duchin, R., O. Ozbas, and B. A. Sensoy (2010): "Costly external finance, corporate investment, and the subprime mortgage credit crisis", *Journal of Financial Economics*, 97, 418–435.

Duval, R., G. H. Hong, and Y. Timmer (2019): "Financial frictions and the great productivity slowdown", *Review of Financial Studies*, (fothcoming).

Faulkender, M. and R. Wang (2006): "Corporate financial policy and the value of cash", *The Journal of Finance*, 61, 1957–1990.

Favara, G. and J. Imbs (2015): "Credit supply and the price of housing", *American Economic Review*, 105, 958–92.

Fresard, L. (2010): "Financial strength and product market behavior: The real effects of corporate cash holdings", *The Journal of finance*, 65, 1097–1122.

Froot, K. A., D. S. Scharfstein, and J. C. Stein (1993): "Risk management: Coordinating corporate investment and financing policies", *the Journal of Finance*, 48, 1629–1658.

Gilchrist, S., R. Schoenle, J. Sim, and E. Zakrajšek (2017): "Inflation dynamics during the financial crisis", *American Economic Review*, 107, 785–823.

Han, S. and J. Qiu (2007): "Corporate precautionary cash holdings", *Journal of Corporate Finance*, 13, 43–57.

Harford, J. (1999): "Corporate cash reserves and acquisitions", *The Journal of Finance*, 54, 1969–1997.

Harford, J., S. A. Mansi, and W. F. Maxwell (2008): "Corporate governance and firm cash holdings in the us", *Journal of Financial Economics*, 87, 535–555.

Ivashina, V. and D. Scharfstein (2010): "Bank lending during the financial crisis of 2008", *Journal of Financial Economics*, 97, 319–338.

Iyer, R., J.-L. Peydró, S. da Rocha-Lopes, and A. Schoar (2014): "Interbank liquidity crunch and the firm credit crunch: Evidence from the 2007–2009 crisis", *The Review of Financial Studies*, 27, 347–372.

Jeenas, P. (2018): "Firm balance sheet liquidity, monetary policy shocks, and investment dynamics", Mimeo New York University.

Jensen, M. C. and W. H. Meckling (1976): "Theory of the firm: Managerial behavior, agency costs and ownership structure", *Journal of financial economics*, 3, 305–360.

Jordà, Ò. (2005): "Estimation and inference of impulse responses by local projections", *American Economic Review*, 95, 161–182.

Jordà, Ò., M. Schularick, and A. M. Taylor (2013): "When credit bites back", *Journal of Money, Credit and Banking*, 45, 3–28.

Kalemli-Ozcan, S., L. Laeven, and D. Moreno (2018): "Debt overhang, rollover risk, and corporate investment: Evidence from the European crisis", CEPR Discussion Paper No. 12881.

Kalemli-Ozcan, S., B. Sorensen, C. Villegas-Sanchez, V. Volosovych, and S. Yesiltas (2015): "How to construct nationally representative firm level data from the orbis global database", NBER Working Paper No.21558.

Keynes, J. M. (1936): *The general theory of employment, interest, and money*, Springer Brace, London.

Kim, C.-S., D. C. Mauer, and A. E. Sherman (1998): "The determinants of corporate liquidity: Theory and evidence", *Journal of Financial and Quantitative Analysis*, 33, 335–359.

Lian, C. and Y. Ma (2018): "Anatomy of corporate borrowing constraints", Mimeo MIT and University of Chicago Booth.

MacKay, P. and G. M. Phillips (2005): "How does industry affect firm financial structure?", *Review of Financial Studies*, 18, 1433–1466.

Mian, A., A. Sufi, and E. Verner (2017): "Household debt and business cycles worldwide", *The Quarterly Journal of Economics*, 132, 1755–1817.

Office for National Statistics (2017): "Annual Respondents Database X, 1998-2014: Secure Access", Virtual Microdata Laboratory (VML), University of the West of England, Bristol, SN: 7989.

Ongena, S., J.-L. Peydro, and N. Van Horen (2015): "Shocks abroad, pain at home? Bank-firm-level evidence on the international transmission of financial shocks", *IMF Economic Review*, 63, 698–750.

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

Ottonello, P. and T. Winberry (2018): "Financial heterogeneity and the investment channel of monetary policy", NBER Working Paper No. 24221.

Pinkowitz, L., R. Stulz, and R. Williamson (2006): "Does the contribution of corporate cash holdings and dividends to firm value depend on governance? A cross-country analysis", *The Journal of Finance*, 61, 2725–2751.

Puri, M., J. Rocholl, and S. Steffen (2011): "Global retail lending in the aftermath of the us financial crisis: Distinguishing between supply and demand effects", *Journal of Financial Economics*, 100, 556–578.

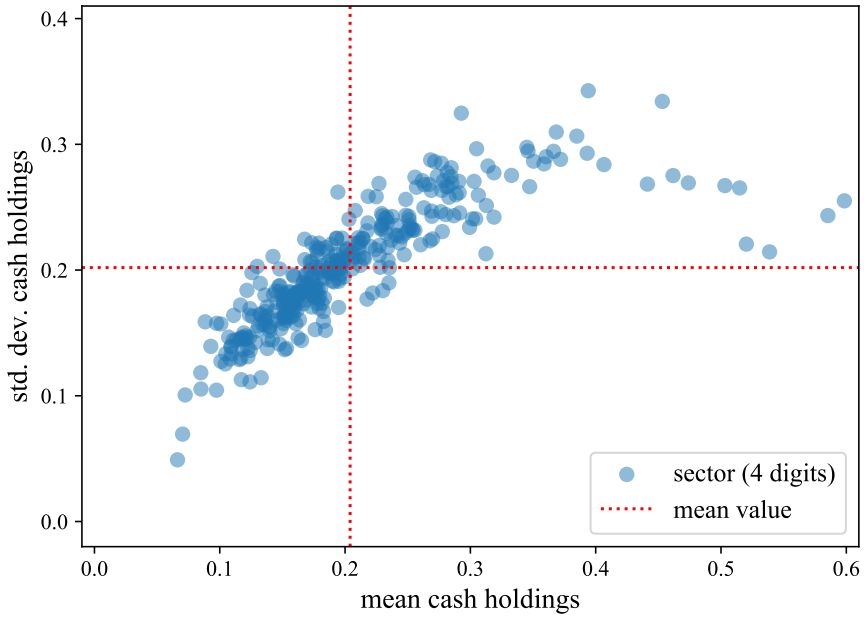
Santos, J. A. (2011): "Bank corporate loan pricing following the subprime crisis", *The Review of Financial Studies*, 24, 1916–1943.

Song, K. R. and Y. Lee (2012): "Long-term effects of a financial crisis: Evidence from cash holdings of east asian firms", *Journal of Financial and Quantitative Analysis*, 47, 617–641.

Sufi, A. (2009): "Bank lines of credit in corporate finance: An empirical analysis", *The Review of Financial Studies*, 22, 1057–1088.

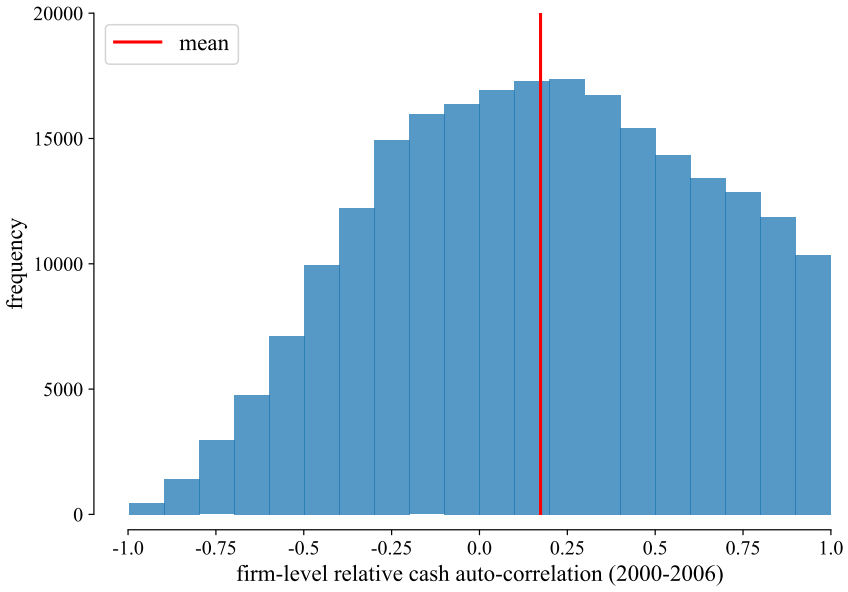
Wix, C. (2017): "The long-run real effects of banking crises: Firm-level investment dynamics and the role of wage rigidity", SAFE Working Paper No. 189.

Figure 1: Variations in cash holdings by industry (2006)



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

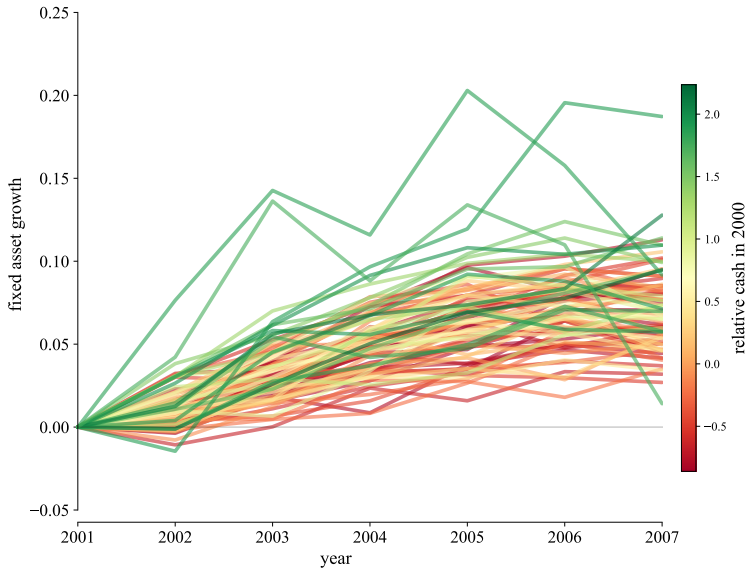
Figure 2: Auto-correlation relative cash



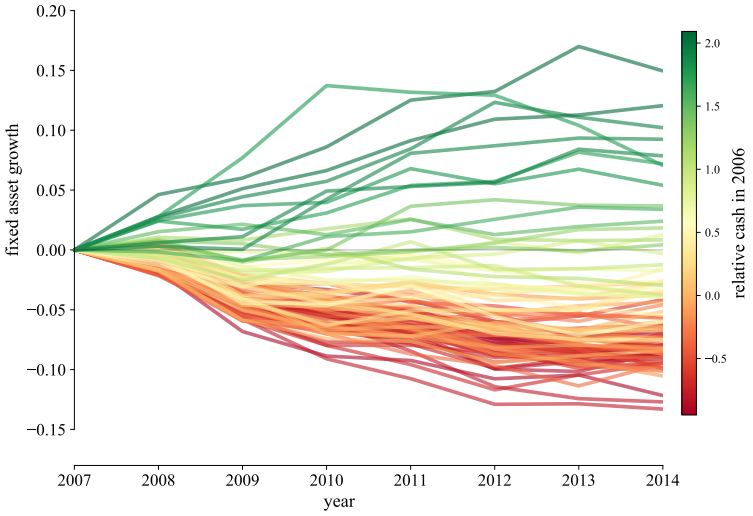
Notes: This figure plots the distribution of the one-lag auto-correlation coefficient of relative cash over the period 2000 to 2006 of the firms in the crisis sample. Relative cash is calculated by subtracting from the firm's cash holdings its industry mean and divide the difference by the industry standard deviation. Industry mean and standard deviation are determined at the 4-digit level. The vertical red line marks the man of the distribution.

Figure 3: Investment high vs low cash firms: pre-crisis and crisis period

(a) *Panel A: Pre-crisis period: 2001-2007*

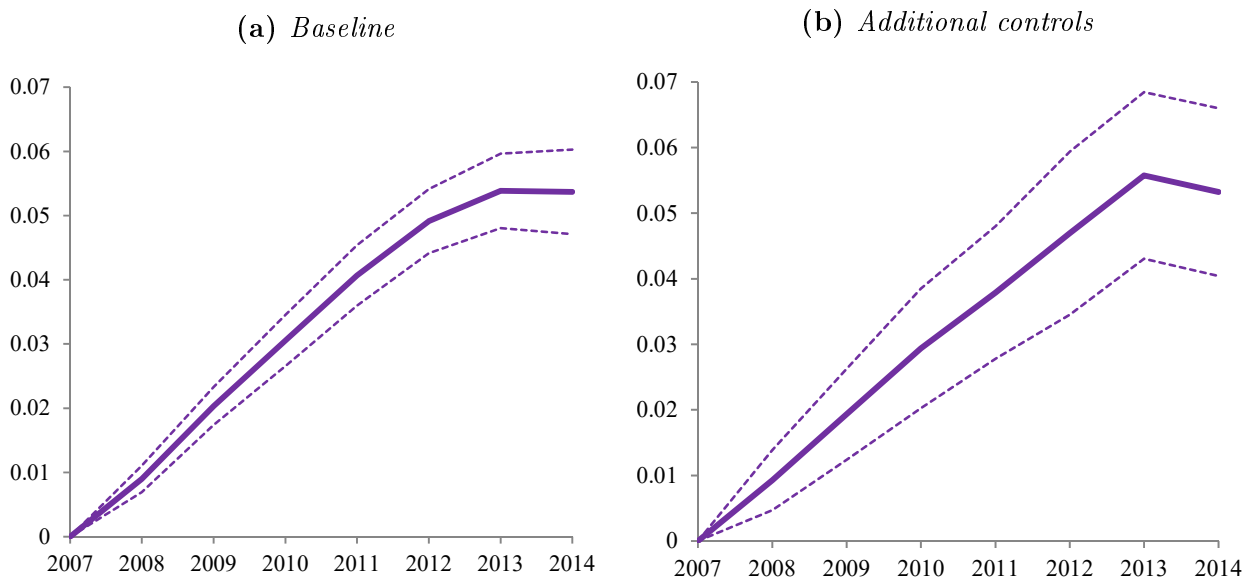


(b) *Panel B: Crisis period: 2007-2014*



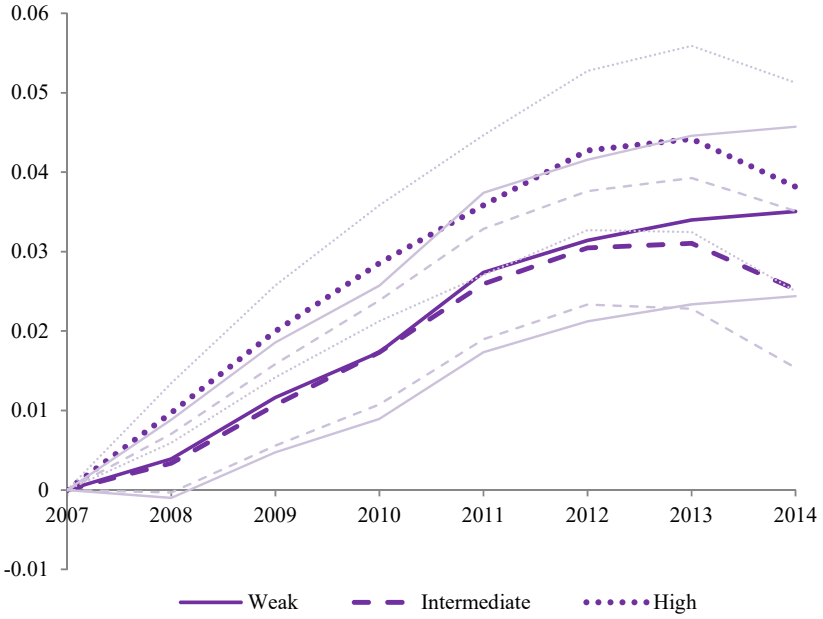
Notes: These figures plot the average fixed asset growth for firms in each percentile of relative cash within the 90 percent interquartile range. In panel A average fixed asset growth is tracked over the period 2001-2007 and in panel B over the period 2007-2014. Fixed asset growth is defined as the log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

Figure 4: Long-term impact of cash on investment



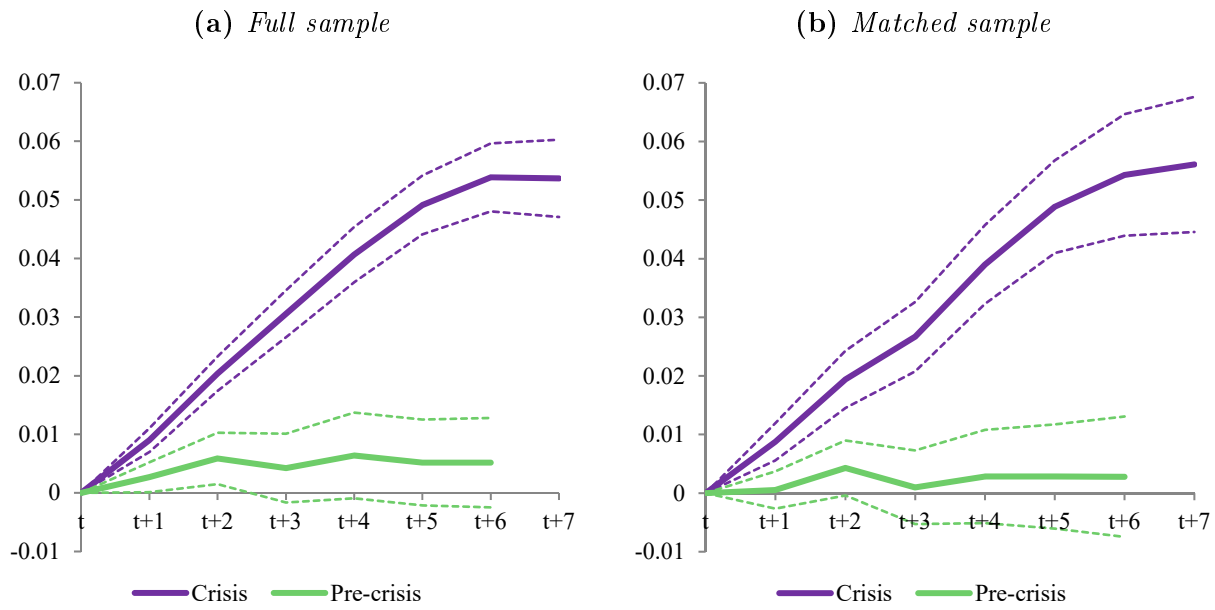
Notes: These figures plot the impact of relative-to-rivals cash on investment over different horizons using local projections. The dependent variable is the cumulative fixed asset growth between 2007 and $2007 + j$, where j ranges from 1 to 7. The model specification used in the right-hand side panel 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 aprameter of *Relative cash* and the dashed lines show the 90 percent confidence intervals.

Figure 5: Long-term impact of cash on investment - persistence of cash holdings



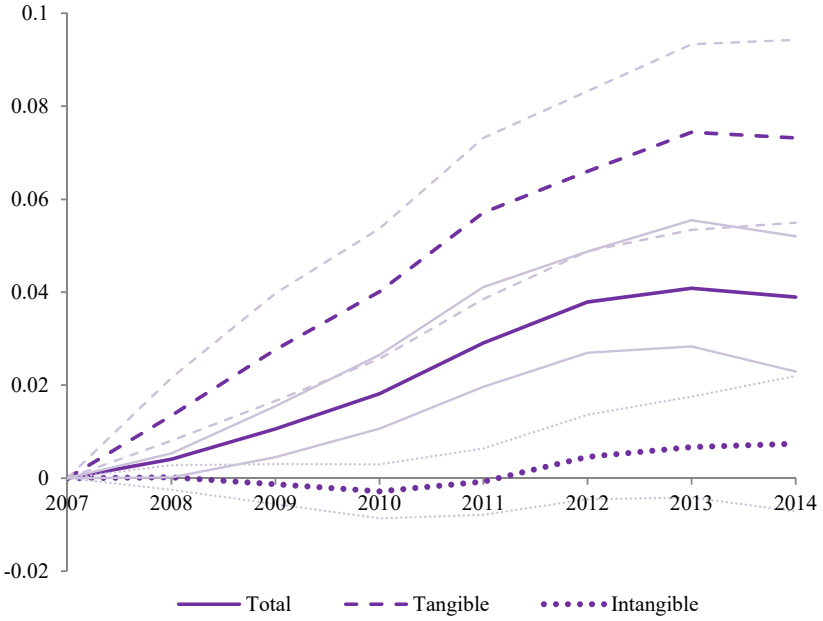
Notes: This figure plots the impact of relative-to-rivals cash on investment over different horizons using local projections for subsets of firms with weak, intermediate or high persistence of relative-to-rivals cash holdings. Cash persistence is measured as the one-lag auto-correlation coefficient of Relative cash over the period 2000 to 2006. Firms with weak cash persistence are those ranked in the lower tercile of the persistence distribution, firms with intermediate persistence are those ranked above the lower and below the upper tercile of the distribution, and firms with high persistence are those ranked above the upper tercile of the distribution. The dependent variable is the cumulative fixed asset growth between between 2007 and 2007+j, where j ranges from 1 to 7. The regressions are based on a sub-set of 115,494 firms who report information on their cash holdings each year between 2000 and 2006. All regressions include the standard control variables and region and 4-digit industry fixed effects. Standard errors allow for corrrelation at the 4-digit industry level. The dark-colored lines correspond to the estimated parameter of Relative cash and the corresponding light-colored lines show the 90 percent confidence intervals.

Figure 6: Long-term impact of cash on investment - crisis vs pre-crisis period



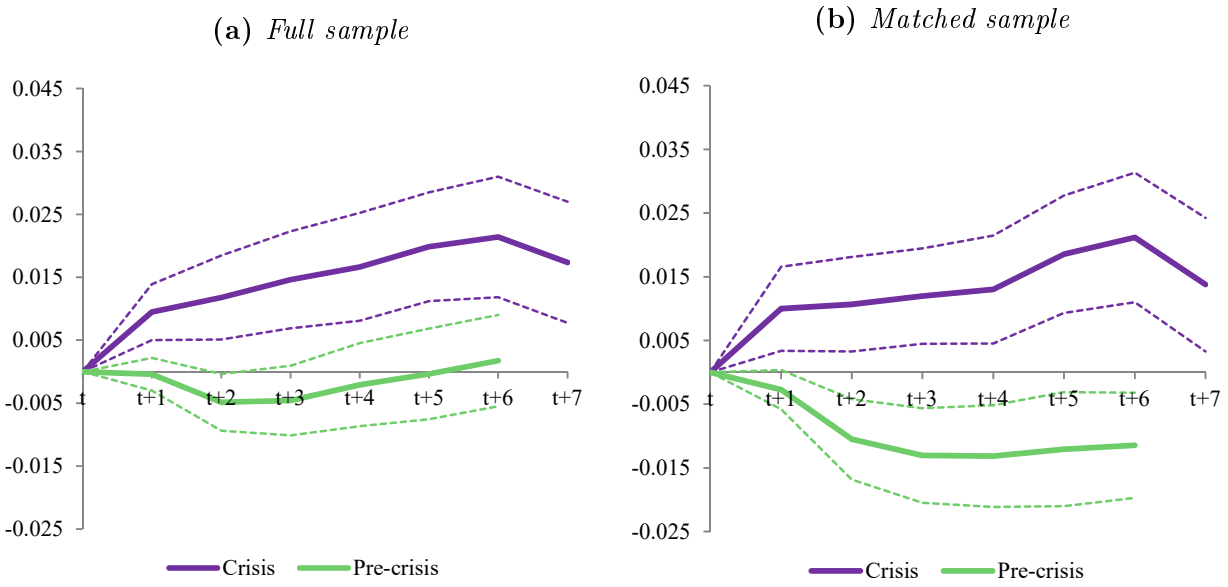
Notes: These figures plot the impact of relative-to-rivals cash on investment over different horizons using local projections for the crisis and pre-crisis periods. The dependent variable is the cumulative fixed asset growth between 2007 and 2007+j, where j ranges from 1 to 7 for the crisis sample and 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 matched sample includes the subset of firms that are exactly matched on 4-digit industry, region, age category, size category and quartiles of leverage, profit, and investment with all variables measured in 2006 for the crisis sample and in 2000 for the pre-crisis sample. All regressions include the standard control variables and region and 4-digit industry fixed effects. Standard errors allow for corrrelation 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 7: Long-term impact of cash on investment - tangible vs intangible



Notes: This figure plots the impact of relative-to-rivals cash on investment in tangible and intangible fixed assets 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, where fixed asset growth captures the growth in tangible, intangible or total fixed assets respectively. The regressions are based on a sub-set of 16,616 firms that report information on both tangible and intangible assets. All regressions include the standard control variables and region and 4-digit industry fixed effects. Standard errors allow for corrrelation at the 4-digit industry level. The dark-colored lines correspond to the estimated parameter of Relative cash and the corresponding light-colored lines show the 90 percent confidence intervals.

Figure 8: Long-term impact of cash on market share - crisis vs pre-crisis period



Notes: These figures plot the impact of relative-to-rivals cash on market share growth over different horizons using local projections for the crisis and pre-crisis periods. The dependent variable is the cumulative market share growth betwen 2007 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. Market share growth is defined as the percentage change of the firm's assets relative to its total industry assets (at the 4-digit industry level). The full sample includes all firms for which information is available. The matched sample includes the subset of firms that are exactly matched on 4-digit industry, region, age category, size category and quartiles of leverage, profit, and investment with all variables measured in 2006 for the crisis sample and in 2000 for the pre-crisis sample. All regressions include the standard control variables and region fixed effects. Standard errors allow for corrrelation 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.

Table 1: Summary statistics

Variable	Obs	Mean	Median	St. Dev.	Min	Max
Crisis sample						
Δ lnFA (2007-2014)	235,396	-0.06	-0.02	1.00	-3.45	4.09
Relative cash	235,396	-0.14	-0.42	0.85	-1.42	2.89
Leverage	235,396	0.62	0.60	0.39	0.00	3.47
Size	235,396	5.55	5.53	1.64	1.10	10.30
Mature	235,396	0.19	0.00	0.39	0	1
Old	235,396	0.25	0.00	0.43	0	1
Group	235,396	0.09	0.00	0.29	0	1
Public	235,396	0.00	0.00	0.01	0	1
Profit	235,396	0.29	0.31	0.40	-3.18	0.99
Pre-Investment (1st lag)	235,396	0.03	0.00	0.38	-1.35	2.20
Pre-Investment (2nd lag)	235,396	0.05	0.00	0.40	-1.26	2.27
Pre-Turnover growth (1st lag)	34,519	0.06	0.05	0.31	-1.83	1.64
Pre-Turnover growth (2nd lag)	34,519	0.09	0.06	0.33	-1.74	1.99
%ΔMshare (2007-2014)	230,077	0.17	-0.08	1.01	-0.95	9.04
Pre-Market share growth (1st lag)	230,077	0.01	-0.06	0.33	-0.70	2.54
Pre-Market share growth (2nd lag)	230,077	0.04	-0.05	0.40	-0.70	3.52
Σ Profit (2007-2014)	226,887	2.47	2.42	3.64	-28.67	15.70
Σ ROA (2007-2014)	17,876	1.13	0.68	1.87	-6.87	16.50
ΔlnEmpl (2007-2014)	10,799	0.07	0.05	0.50	-2.71	1.84
Pre-crisis sample						
ΔlnFA (2001-2007)	158,175	0.07	0.00	0.96	-3.40	3.87
Relative cash	158,175	-0.13	-0.44	0.85	-1.30	3.11
Leverage	158,175	0.63	0.62	0.38	0	3.33
Size	158,175	5.67	5.69	1.60	1.10	10.39
Mature	158,175	0.26	0.00	0.44	0	1
Old	158,175	0.32	0.00	0.47	0	1
Group	158,175	0.13	0.00	0.34	0.00	1.00
Public	158,175	0.00	0.00	0.01	0.00	1.00
Profit	158,175	0.27	0.28	0.40	-3.00	0.98
Pre-Investment (1st lag)	158,175	0.03	0.00	0.39	-1.50	2.14
Pre-Investment (2nd lag)	158,175	0.07	0.00	0.41	-1.39	2.30
%ΔMshare (2001-2007)	154,760	0.03	-0.21	0.87	-0.96	7.64
Pre-Market share growth (1st lag)	154,760	0.02	-0.04	0.35	-0.73	2.81
Pre-Market share growth (2nd lag)	154,760	0.01	-0.06	0.39	-0.74	3.42

Notes: This table shows the summary statistics of the key variables used in the analysis

Table 2: Pre-crisis characteristics high cash and low cash firms

Variable	High relative cash	Low relative cash	Difference	
Cash holdings	0.57	0.03	0.54	***
Size (th)	684	1,700	-1015	***
Young (<10y)	0.58	0.56	0.02	***
Fixed assets	0.20	0.44	-0.24	***
Leverage	0.48	0.77	-0.29	***
Profit	0.47	0.15	0.32	***
Investment	0.04	0.04	0.00	

Notes: This table presents difference-in-difference estimate from a Mann-Whitney two-sided t-test on selected pre-crisis balance sheet characteristics of firms with high and low cash relative to their industry rivals. High relative cash firms are those firms in the top quartile of relative-to-rivals cash distribution and low relative cash firms are those in the bottom quartile of the distribution as measured in 2006. *Cash holdings* denotes the firm's deposits over total assets. *Size* denotes the firms' total assets (in thousands). *Young* is a dummy which is one if the firm is 10 years or younger. *Fixed assets* denotes the firms' share of fixed assets over total assets. *Leverage* denotes the share of total liabilities over total assets. *Profit* denotes the firm's profit over total assets. *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. *** indicates significance at the 1% level, ** at the 5% level, and * at the 10% level.

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

Financial constraints criteria	Constrained	Unconstrained	Difference (p-value)
Age	*Young*	*Old*	
	0.068***	0.034***	0.00***
	(0.005)	(0.007)	
	132,142	*58,162*	
Size	*Small*	*Large*	
	0.087***	0.060***	0.14
	(0.009)	(0.009)	
	58,336	*58,920*	

Notes: This table presents the estimates of relative-to-rivals cash on fixed asset growth from 2007-2014 across different groups or firms. 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. 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. 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	Low	High	Difference (p-value)
	Panel A		
Age	0.068***	0.047***	0.00***
	(0.006)	(0.005)	
	86,540	*38,790*	
Size	0.070***	0.038***	0.00***
	(0.005)	(0.008)	
	111,749	*48,557*	
	Panel B		
Capital intensity	0.057***	0.061***	0.71
	(0.008)	(0.007)	
	51,963	*60,804*	
Concentration	0.046***	0.056***	0.50
	(0.006)	(0.013)	
	114,057	*29,359*	
Depth crisis	0.058***	0.046***	0.25
	(0.006)	(0.008)	
	82,639	*33,547*	

Notes: This table presents the estimates of relative-to-rivals 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 age criteria. *Age* captures the industry mean firm age and *Size* the industry mean firm size. *Caputal 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 masured in 2006. 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: Cross-firm impact cash on market share - 2007-2014

Financial constraints criteria	Constrained	Unconstrained	Difference (p-value)
Age	*Young*	*Old*	
	0.031***	-0.007	0.00***
	(0.008)	(0.007)	
	125,164	*56,933*	
Size	*Small*	*Large*	
	0.057***	0.001	0.00***
	(0.007)	(0.008)	
	53,733	*57,789*	

Notes: This table presents the estimates of relative-to-rivals cash on cumulative market share growth from 2007-2014 across different groups or firms. 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. All regressions include the control variables as specified in model (2) and include 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. 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 6: Cross-industry impact cash on market share growth - 2007-2014

Industry criteria	Low	High	Difference (p-value)
	Panel A		
Age	0.020**	-0.006	0.02**
	(0.009)	(0.007)	
	81,255	*37,951*	
Size	0.021***	-0.014	0.01**
	(0.006)	(0.012)	
	105,926	*47,333*	
	Panel B		
Capital intensity	0.017*	0.029*	0.50
	(0.010)	(0.015)	
	48,502	*59,273*	
Concentration	0.019**	0.021**	0.85
	(0.007)	(0.009)	
	109,933	*27,644*	
Depth crisis	0.007	0.0317**	0.13
	(0.007)	(0.015)	
	79,259	*24,880*	

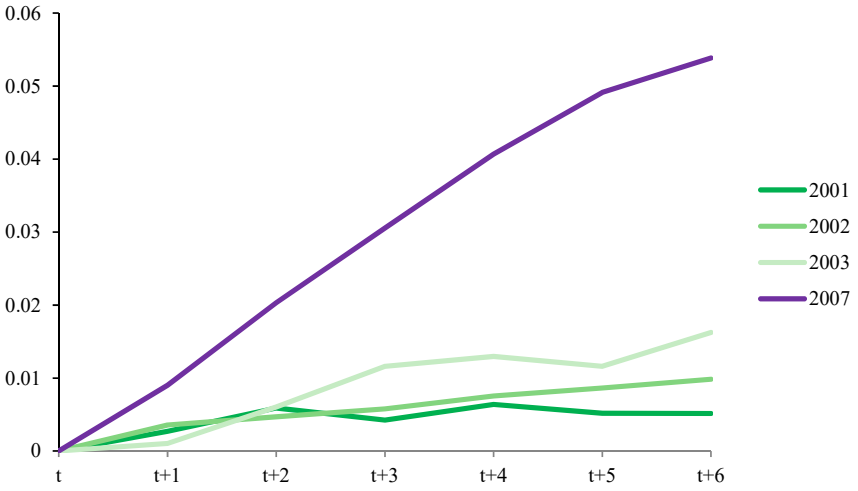
Notes: This table presents the estimates of relative-to-rivals cash on market share growth between 2007-2014 across different industries. Market share growth is defined as the percentage change of the firm's assets relative to its total industry assets (at 4-digit industry level). Industries are classified on the basis of different age criteria. *Age* captures the industry mean firm age and *Size* the industry mean firm size. *Caputal 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 masured in 2006. All regressions include the control variables as specified in model (2) and include 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 7: Cash and firm performance

Dependent variable	Σ Profit		Σ ROA		Δln Employees	
Horizon	*2007-2009*	*2007-2014*	*2007-2009*	*2007-2014*	*2007-2009*	*2007-2014*
	[1]	[2]	[3]	[4]	[5]	[6]
Relative Cash	0.036***	0.195***	0.046***	0.086	0.007*	0.002
	(0.003)	(0.018)	(0.016)	(0.064)	(0.004)	(0.009)
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
R-squared	0.657	0.352	0.401	0.356	0.112	0.080
Nr. observations	*173,851*	*174,473*	*2,078*	*2,079*	*8,958*	*9,193*

Notes: This table presents the estimates of relative-to-rivals cash on different perfomrance measures. The dependent variable is the cumulative profit (columns 1 and 2), the cumulative ROA (columns 3 and 4), and the cumulative growth in the number of employees (columns 5 and 6). Cumulative changes and growth rates are measured between 2007 and 2009 in the uneven columns and between 2007 and 2014 in the even columns. All regressions include the control variables as specified in model (1) except for lagged investment which is replaced by the first and second lag of the respective dependent variables. All regressions include region adn 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 investment - different tranquil periods



Notes: This figure compares the impact of relative-to-rivals cash on investment for different pre-crisis periods with the impact for the crisis period. It plots the impact of relative-to-rivals 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 specificied in model (1) and region and 4-digit industry fixed effects. Standard errors allow for corrrelation at the 4-digit industry level. The lines correspond to the estimated parameter of Relative cash for the four periods.

Apendix Table A1 - Variable Definitions and Sources

Variable	Definition	Source
ΔlnFA	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 and 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
Public	Dummy equal to one if the firm is publicly listed	FAME
Profit	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
%ΔMShare	Growth rate of the firm's market share between 2007 and year 2007+ j (crisis period) or between 2001 and 2001 + j (pre-crisis period), where market share is defined as the ratio of the firm's assets over the total industry assets (at 4-digit level).	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
Σ Profit	Cumulative profits of the firm over the period 2007 to 2009/2014 divided by the firm's assets in 2007	FAME
Σ ROA	Cumulative EBITDA of the firm over the period 2007 to 2009/2014 divided by the firm's assets in 2007	FAME
Δln Employees	Log difference of number of employees between 2007 and 2009/2014	FAME

Notes: This table shows variables definitions and data sources for all the variables used in the empirical analysis.